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ENGINEERING AND MINING JOURNAL

A Consolidation of Engineering and Mining Journal and Mining and Scientific Press

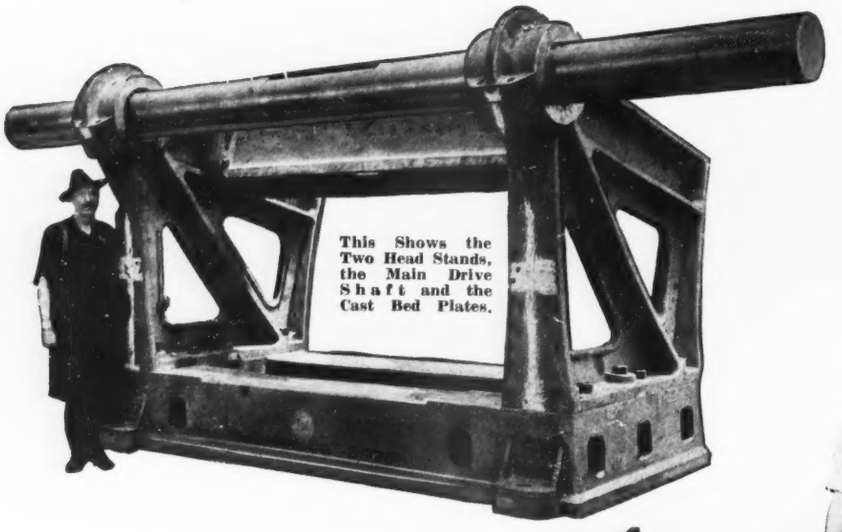
METAL AND NON-METALLIC MINING · MILLING · SMELTING · REFINING · MARKETING

Supporting Underground Openings in Mines
By George J. Young

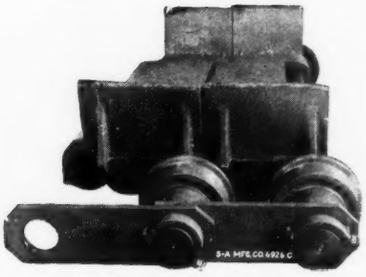
Effect of Soluble Salts on Concentration by Flotation
By A. W. Hahn

Some Iron Country Safety Practices

Heavy ore feeders that handle large tonnages with low cost for upkeep



This Shows the Two Head Stands, the Main Drive Shaft and the Cast Bed Plates.



This View Shows Two Links of One of Two Matched Strands of Chain

Interlocking 72-inch wide conveyor pans with integral side plates. Note independent traction rolls and chain rollers.

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Volume 123 New York, March 12, 1927 *Number* 11

ENGINEERING AND
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Contents

*Illustrated Article

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Editorials 433
- Tempora Mutantur
- New President for the Institution of Mining and Metallurgy in London
- Big Year for A. S. & R.
- Heat Treatment Facilitates Rock Breaking
- Mexican Oil
- A Non-tarnishing Silver Alloy
- On Exposing the Faker
- L'Envoi

*Some Iron Country Safety Practices
- Illustrations

*Supporting Underground Openings in Mines 438
- By George J. Young

Obviating the Harmful Effect of Soluble Salts in Flotation 449
- By A. W. Hahn

Mining News 450
- Gilbert Mammoth Satisfies Judgment
- B. C. Plants Operating at Full Capacity
- Grasfontein Diamond Rush
- Washington News
- Letters from Toronto, Mexico City, London and Johannesburg

Situation at Mines 457
- By Albert H. Fay

Societies, Addresses and Reports 458
- Proposed Plan of Rehabilitation of Hydraulic Mining

Recent Technical Publications 460
- Practical Oil Geology in Its Fourth Edition
- By J. Volney Lewis

Men You Should Know About 461

Obituaries 461

New Machinery 462
- *Handling Flotation Concentrates at the Mill of the Utah-Apex Mining Co.
- By Albert L. Genter

Market and Financial News 465

Market Report 467

Metal Price Curves 469

Review of Current Statistics 470
- By A. B. Parsons

E. & M. J. Statistics of the Mining Industries 471

Mining Stocks 472

Professional Directory 31-33

Searchlight Section 34-36

What and Where to Buy 38-40

Advertising Index 42

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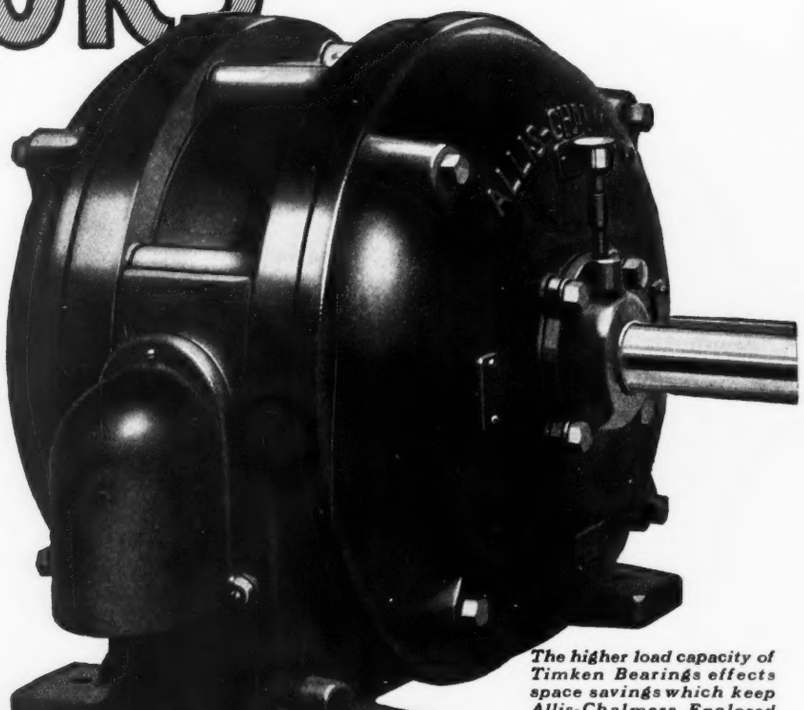

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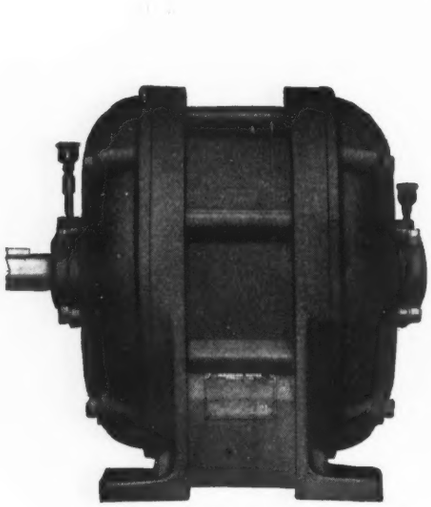

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ENGINEERING AND
MINING JOURNAL

JOSIAH EDWARD SPURR, Editor

Volume 123 | New York, March 12, 1927 | *Number* 11

Tempora Mutantur

EVERYTHING CHANGES. It is the opportunity for growth and evolution: there is a certain sadness about it, but without change and movement and progress it would be far sadder. So in the due course of events the present Editor of *Engineering and Mining Journal* gives up his post on April 15, beyond which date he will have no connection with the paper nor with the company which publishes it. He has served seven years and more—seven pleasant, broadening, busy years; and there may well be something in the American hunch against a Presidential third term. The great advantage of democracy, it has been said, is that you can get a change of bosses every little while; whereas under the older forms of government they stay on far too long. The same argument may be held to apply to editors. Anyhow, the Editor has had a good time, and with the paper in the exceptionally favorable position indicated in our editorial of Jan. 15, it is a good time to swap horses.

The mining industry, which has shown a remarkable support and loyalty to *Engineering and Mining Journal*, has had the major part in developing the paper: without that the paths of journalism would have been thorny instead of easy. On the other hand, the paper has been conducted with an eye single to the service of the mining industry as a whole—not for one group or another—not favoring the little interests nor the big ones—not lead as against copper, or zinc against lead; and with a background of conviction that what was not beneficial to the country would not be beneficial to the mining industry in the long run. In view of the remarkable growth of foreign circulation, the editorial vision has been enlarged to correspond, without forgetting the growth and tradition of the journal as an American paper.

The editorial policy has been independent, and has been solely determined by the Editor. Reader, you who have sometimes approved and disapproved, sometimes agreed and sometimes condemned: please grant the recognition of the honest intention, and the desire to be fair and fearless without being destructive. The Editor turns to other fields with many pleasant memories.

New President for the Institution of Mining and Metallurgy in London

THE ELECTION of a new president for the Institution of Mining and Metallurgy, in London, is a matter of interest to our world-wide profession. We learn that Sir Thomas Holland, who has been so satisfactory a president as to serve two terms, is to be succeeded by Mr. Robert E. Palmer, whose name has been long and intimately associated with the famous Rio Tinto mine. Mr. Palmer was born on Prince Edward Island, and consequently is a Canadian. His father was Chief Justice of the province, and therefore it is evident that he started life under favorable auspices. In 1883 he entered McGill University, and graduated in civil engineering four years later, with high honors. Soon after graduation he went to Vancouver, where he engaged in professional work, and, what is more important, entered the holy state of matrimony most happily. Then, at the instance of his friend William A. Carlyle, he went to Rossland as chief of the engineering staff and later superintendent of the Le Roi mine, which was under Mr. Carlyle's management.

When Mr. Carlyle became manager of the Rio Tinto, in December, 1899, he again asked Mr. Palmer to join him, to take charge of the underground work. Mr. Palmer reached Spain in September, 1900. We are told that he did "splendid work" and eventually had control of the San Dionisio open cut, which was begun in 1908. After that he had charge of other, even larger, operations, and in each instance proved himself an accomplished engineer. He then became assistant manager, but in 1913 he was called by the Rio Tinto company to the head office in London, to act as consulting engineer to the company. This post he still retains.

In 1916 Mr. Palmer and his friend Professor Carlyle were commissioned by the British Government to examine and report on the many tin mines in Almeria (Spain) that the Germans were said to be about to acquire. For this and other services during the war he was given the distinction of O.B.E. (Order of the British Empire).

Mr. Palmer is one of the leaders of the mining profession, being ranked as such by his fellows on account of his ability and integrity alike. His personally engaging qualities have made him much liked by the many that have the pleasure of his acquaintance. The news of his election therefore has been received with keen pleasure, and with complete confidence that he will make an admirable president of the Institution.

Big Year for A. S. & R.

ALTHOUGH the position of the American Smelting & Refining Co. is not an infallible index to the prosperity of mining in North America, at least it can be said that if the Smelting company did *not* thrive during any year, neither did metal producers in general. It might be possible for production to proceed at the maximum rate, thereby affording the Smelting company a highly satisfactory income on custom ores, even though current metal prices were not sufficiently high to return abundant profits to most producers of ore. Some such situation as this has obtained during the last three or four months. However, long duration of such a condition would eventually be reflected in smaller intake by the smelter. Moreover, the A. S. & R. is steadily increasing the quantity of ore mined on

its own account, through subsidiaries, so that its earnings depend in an increasing degree on metal prices.

Everything considered, the report just issued by the company for 1926 reflects a most satisfactory condition for metal mining, taking the year as a whole. The following data show a progressive improvement during the last five years, as indicated by the rate of earnings per share of common stock after deducting all costs and the dividends on the preferred stock:

1922	$3.28	1925	$19.17
1923	8.89	1926	23.38
1924	12.60		

Part of this improvement is accounted for by increased mine profits, particularly in Mexico and Peru; and part by greater income from custom business. The expansion in activity in the industry in general is reflected in the accompanying table comparing production by the A. S. & R. Co. in 1926 with that of 1925.

	1925	1926
Gold, ounces	1,667,849	1,634,158
Silver, ounces	82,223,189	85,482,438
Lead, tons	455,261	469,607
Copper, tons	502,831	525,897
Zinc, tons	45,246	48,723
Bullion refined, tons	936,346	990,295
Charge smelted, tons	5,638,730	5,433,547
Ore mined, tons	1,656,212	1,875,991
Number men employed	26,401	28,612

An idea of the magnitude of the company's smelting and refining operations is revealed by a comparison of some of these figures with those for the entire production in the United States during 1926. The percentages are as follows: copper, 60; gold, 75; lead, 80; and silver, 135. It is well known, of course, that much of the metal comes from foreign sources.

The comparison between the two years shows only two declines: in gold production and in tons of charge smelted. The first doubtless indicates lower receipts of gold-bearing custom bullion shipped to the company's plants for refining. The latter reflects improved practice in concentration whereby products of higher metal content are prepared for shipment to the smelter. The report may safely be interpreted as a good omen for the metal-mining industry.

Heat-Treatment Facilitates Rock Breaking

AN INTERESTING INVESTIGATION of heat-treatment as an agent in rock breaking has been made by Bernard W. Holman, who has a paper on the subject in the January *Bulletin* of The Institution of Mining and Metallurgy. Mr. Holman's attention was first attracted by the appearance of Roman mine workings at Dolancothy, South Wales. He states that he was impressed by the apparent efficiency of the ancient fire-workings and noted that the stopes were clean, the walls, where still standing, were undamaged, and the amount of fuel used appeared to have been small. In the investigation that followed, chiefly laboratory, Mr. Holman demonstrated that if many forms of quartz, or even of ores rich in quartz, as "banket," are heated at a suitable rate to a temperature between 560 and 600 deg. C. and properly quenched, they undergo a remarkable physical change and may be rendered so friable that material from a rock breaker can, after such heat-treatment, be reduced to powder with the finger and thumb. His experiments showed that heating should be rapid, for a short period and at not too high a temperature.

Other investigators have worked upon this subject, but the field as a whole has been only scantily tried out. The effect of heating and quenching upon minerals may be comparatively unimportant, but nevertheless comprehensive knowledge is absent. The steel user and the alloy maker have benefited by the results of investigations upon the heat-treatment of metals and alloys, and a surprising amount of information about changes in molecular constitution is now available and has had the effect of provoking continued, extensive investigation that has proved in many instances commercially important.

The pioneer work by Mr. Holman and others, stimulated by the fact that the ancients had some valuable practicable knowledge about breaking rocks, by heating and quenching, may likewise prove to be commercially important through simplification of mechanical equipment and by increasing the capacity of fine grinders. Furthermore, it should stimulate investigation of gangue minerals other than quartz, as well as rocks.

Mexican Oil

IN THE ISSUE of *E. & M. J.* of March 5, 1927, on page 409, there appears, under "Propaganda," a quotation purporting to be from the Secretary of State as of Feb. 16, 1927, who is alleged to have said:

"That 90 per cent of the *owners of oil lands* in Mexico acquired by foreigners prior to May 1, 1917, have not complied with the law, given up their titles in fee simple for concessions."

What the Secretary of State did say was: "The Department understands that the American and Mexican corporations herein above listed as having refused or failed to accept the provisions of the petroleum law of Mexico control about 90 per cent of the *actively petroleum-producing lands* of Mexico acquired before the Mexican constitution of 1917, and that they produce about 70 per cent of the oil produced in Mexico." There is an essential difference in the meaning conveyed. Compare the words which we have italicized in the two quotations.

The decision of the United States Supreme Court in the Elk Hills Doheny case shows that the lease was not obtained in accordance with the law. Certain Mexican titles may not be perfect, and Mexico is trying to do exactly what our Supreme Court has done—determine the validity of titles and leaseholds.

The Mexican situation is pretty well summed up in an editorial of the New York *World*, March 2, 1927, in which it says:

"If they (European companies) are disregarded, it then follows that the protesting American companies in 1926 produced 58.21 per cent of Mexican oil. If the two European companies are not disregarded, but are listed as protesting, then the opposition, including some unimportant companies (2.59 per cent), represents 75.06 per cent of Mexican production.

"Of this opposition, the two old Doheny companies represent 48 per cent, or nearly half, if the European companies are included. *But of the American companies, according to their own figures, the old Doheny companies represent 62 per cent.*

"Three-fifths of the property interest on which this dispute turns was acquired and managed by Edward L. Doheny up to 1925. This is very significant. The bulk of the rest of the protesting American interest is

represented by Sinclair, Mellon, and a Standard Oil company. The Mexicans are on record as saying that the Sinclair and Mellon interests have a record of fair dealings with Mexico and that their titles are not seriously disputed. But the Doheny titles, according to charges made in the Mexican Congress, are tainted with fraud.

"It has taken the United States courts three years to a day, from the time the Senate authorized the appointment of special counsel, to determine that when the Elk Hills property was acquired by Edward L. Doheny 'the whole transaction was tainted with corruption.' It would indeed be a spectacle if the United States Government, having recovered its property which was taken by fraud, should turn around and insist at the risk of a rupture in diplomatic relations that everything this same Doheny acquired in Mexico was sacred and inviolable."

A Non-tarnishing Silver Alloy

ONE OF THE DISADVANTAGES of silver that has operated against its use and popularity is its susceptibility to tarnish. In most homes, particularly those that are artificially heated, a certain amount of sulphur gas is present in the air, not enough to be noticeable to the senses, but sufficient to produce, in the course of a few weeks, a disagreeable brownish-black coating on silver objects exposed in the house. The effect of the sulphur in eggs on silver table utensils is well known. To be sure, this coating may be removed easily by electrolysis, merely immersing the object for a minute or two in a boiling solution of a teaspoon or so of salt and soda in a gallon of water while the silver rests on a piece of aluminum or zinc, but this treatment cannot easily be applied to large objects, and must be done frequently. Without doubt, if the beauty of untarnished silver could be preserved, its popularity would be increased, which would be a very desirable circumstance considering the present condition of the silver market.

For some time the U. S. Bureau of Standards and the U. S. Bureau of Mines have been experimenting to see if it be possible to make a high silver alloy that would have marked tarnish-resisting properties. So far, they have not had any great success, though alloys have been discovered that are considerably more resistant to tarnish than is sterling silver. Both binary and ternary alloys were tested. Among the binary alloys, cadmium and zinc were the most satisfactory metals to add to silver to increase resistance to tarnish, though the tensile strength of the alloys with these metals was low. This last-named property could be improved by the addition of antimony or tin, making a ternary alloy with a silver content of at least 92½ per cent, so that a silver metal of sterling fineness resulted. It was also found possible to add more of the base metals, and to bring up the intrinsic value of the alloy by the further addition of gold, such an alloy also being reasonably resistant to tarnish. However, the problem cannot be said to have been solved, as no strictly non-tarnishing alloy has been developed, and it is understood that the research is continuing.

This is only one of the phases of the work being done to popularize silver. It is, of course, a more productive form of activity than merely advertising the virtues of the metal in its common form. A superior product is bound to have a wider appeal: witness the increasing use and popularity of chromium since its adaptability to electro-plating has been developed.

On Exposing the Faker

IS IT WORTH WHILE to expose the faker and hold up the spurious to scorn and ridicule? It seems that it ought to be, for fundamental reasons. But much depends upon the audience. Who, for instance, most need cautioning against the doodle bug and the wildcat mining stock? Clearly, those who are ignorant of mining matters. Such are not among those sought by the *Engineering and Mining Journal* for its readers. But frequently the editor catches such a fish, despite the paper's selected circulation. Too frequently it happens that, after an editorial campaign against the doodle bug, Mr. Fish writes in saying that he has read the editorial and wants to know where he can buy one of those contraptions. This contributes to editorial despair. Why campaign at all, then, if a publication's proper readers already understand, and those whose reading is only accidental cannot understand or will not? Manifestly, it is better to abandon all pretence at education and set forth the stories of the swindler and his brethren simply to amuse and interest. In some such spirit the editor of the *Indian & Eastern Engineer* for January describes at length "tests" made with the divining rod in Bombay by J. Alexander Mitchell, F.G.S. Skeptical at the outset, Mr. Mitchell "was astounded to find that the divining rod *in his hands* responded to the influence of concealed running water and to metals and minerals." Since then "he has sedulously fostered the gift, so that his powers have grown and developed by use." All of which indicates the occult or an inclination to believe in it by Mr. Mitchell or the editor who writes of him. The latter asks for comment, stating that he has a perfectly open mind, and feels that out-and-out credulity and skepticism are alike to be eschewed. Open-minded this is, indeed! But the weight of intelligent opinion is against the belief in the divining rod and those who claim ability to find things with it.

L'Envoi

ON FINISHING the leading editorial it seemed to have gone too far, or not far enough. Fancy, once bestirred, continued it, and had gone to the length of an epitaph, before it was guiltily arrested. Abashed, it found itself constructing:

> Stranger, pause, and shed a tear;
> An honest editor lies here.

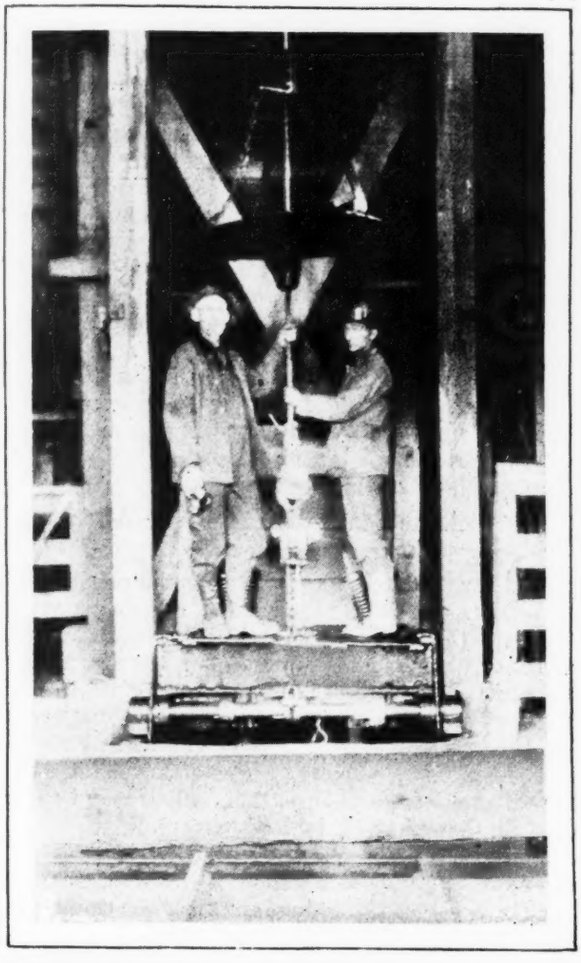
Whereupon the magic works, the stranger appears, without being desired—and sheds a tear—then writes beneath:

> Rest, gentle spirit, ever more
> Lie as thou often didst before.

The stranger, it seemed then, might be the spirit of some indignant contributor to Discussion. It would never do to give him an opening like that. So nimble Fancy proceeded to change the verb and cut out the stranger:

> Underneath this humble bier
> An honest editor lays here.

Whereupon we strangled Fancy once and for all.



Iron Country Safety Practices

Some Iron Country Safety Practices

A Few of the Devices Used by Cleveland Cliffs Iron Co. to Protect Life and Property

SOME OF THE PRACTICES followed by the Cleveland-Cliffs Iron Co. in its mines on the Marquette Range in northern Michigan are shown in the several illustrations on this and the opposite page. Careful attention has been given by this company to safeguarding its employees against accident, and its engineering and safety practices are considered to be the best in the Lake Superior iron country.

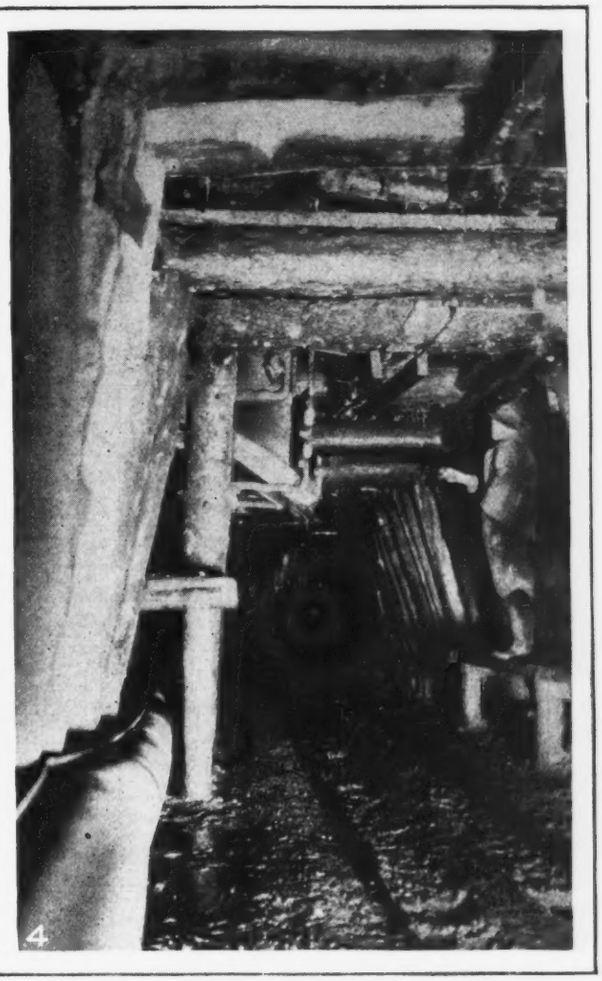
The company uses sheet-metal bulkheads and fire doors in its mines. This practice is illustrated in (1). To control the air currents in case there should be an underground fire, the large bulkheads made of sheet metal on wooden studding and equipped with fire doors similar to the one shown in the photograph have been built in the old open stopes of the Cliffs Shaft mine at Ishpeming. The fire doors are equipped with a special air line so that they can be closed from the surface or from various parts of the mine in case of need. The photograph shows the post to which the fire door is latched and the air pipe ending in a small piston. When the air is turned into the line this piston is extended and unlatches the door, which is then closed by a counterweight.

For protection to the men who ride the skip during the shift, the company has provided a safety bonnet which is built above the skip. A metal platform is placed just above the crosshead of the skip for the men to stand upon and a large disk of heavy metal is attached in place on the rope 7 ft. above the platform as a protection against ore or material falling down the shaft. As an emergency device where riding on the skip is necessary, this is said to be a great improvement over the usual practice. The skips are changed for man cages whenever the shift is lowered or raised. This is illustrated in (2).

In the photograph (3) opposite is shown the device used to protect workmen's hands when loading cars at the ore chutes. The strap of heavy iron, raised as shown over the end of the car protects the fingers against being crushed or bruised by heavy pieces of ore.

Accidents to men engaged in loading cars at chutes are prevented by the use of loading platforms. These are shown in (4). Two platforms are used in this system of loading, the higher one at the left of the picture being used by the man who manipulates the stop boards of the chute. The stop boards extend well beyond the side of the chute and are framed down so as to end in smooth, convenient handles. One man operates them while another stands on the loading platform at the right and bars the chute. The ore in the mine where this is practiced is soft and sticky but contains numerous hard chunks.

Another safety practice adopted by the company is shown in (5). It consists of a device employed to protect the ventilating doors used underground. The photograph shows the door in the main haulage road and the special man door at the side. Wherever possible special man doors are provided to avoid accidents from men being injured by the sudden opening of the man door



by the air cylinders. The photograph shows the red and green lights which warn the motorman whether the door is fully opened or not. In this installation the red light shows unless the door is fully opened and latched.

The foregoing and other mine safety practices were described by J. J. Forbes, of the U. S. Bureau of Mines, in a paper presented by him at the last meeting of the National Safety Council at Detroit.

Supporting Underground Openings in Mines

The Trend of Present Practice

By George J. Young
Associate Editor

ON SEVERAL OCCASIONS I have presented general articles on the subject of underground support in mines, and it would appear that there is comparatively little to add to what has been already published, but as mining experience advances even a subject such as this one can be presented to advantage from different angles of view. Particularly is this so with respect to tendencies of practice.

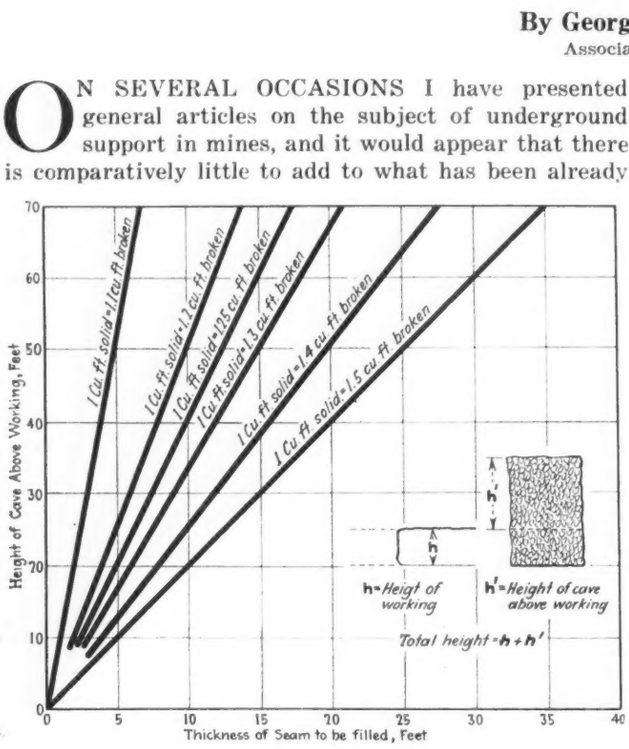

1 Cu. Ft. solid = 1.1 Cu. Ft. broken
1 Cu. Ft. solid = 1.2 Cu. Ft. broken
1 Cu. Ft. solid = 1.25 Cu. Ft. broken
1 Cu. Ft. solid = 1.3 Cu. Ft. broken
1 Cu. Ft. solid = 1.4 Cu. Ft. broken
1 Cu. Ft. solid = 1.5 Cu. Ft. broken
h = Height of working
h' = Height of cave above working
Total height = h + h'
Height of Cave Above Working, Feet
Thickness of Seam to be filled, Feet
0
10
20
30
40
50
60
70
5
15
25
35

Fig. 1—Relation between opening and corresponding thickness of top rock required to supply sufficient broken rock to fill opening and space from which derived, assuming various increases in volume of caved rock

Two well-marked trends can be noted. One is the resort to progressive filling of mined-out openings with waste rock in bed and lode mining operations and the other is the use of undercut caving in mining extensive, thick, low-grade orebodies. In coal mining the trend is toward the complete winning of the coal bed by systematic pillar mining closely following the driving of rooms. Extensive pillar-supported areas are thus avoided and control over ventilation is made easier. These modern trends have operated to reduce both the amount and the dimensions of timbers required for the temporary support of workings and have therefore brought about an additional economy in mining. In the support of restricted mine workings such as shafts, adits, crosscuts, drifts, airways, and raises, the tendency is to use reinforced concrete in shafts, stations, adits, crosscuts, and levels where they are to be used for a number of years and to retain the use of timber where workings are only for temporary purposes. However, where ground masses are more or less active, concrete structures are not always advisable, and mining engineers generally avoid using them under these conditions. In stoping where timbering is required no effective substitute is available. Under certain conditions pillars are left either for temporary or permanent support, but the trend of practice is to avoid the use of pillars except where it is necessary to protect shafts and important connections. Timbers treated with preservatives are frequently used in shafts and airways where their length of life is to be greater than three or four years and where ground movement is absent or not such as seriously to weaken timber structures within the period of their service. Fireproofing of all incast openings, either by the use of gunite on timbers (previously treated by preservatives), or the use of concrete linings, is now recognized as an essential feature of good mining practice.

Rock Structure and Properties

Rock masses encountered in mining embrace most of the common igneous and sedimentary rocks. Where such rocks are homogeneous they have usually sufficient strength to support themselves over comparatively wide spans. This applies to the granites and similar plutonics; to the porphyries, metamorphics, and to thick-bedded sandstones and limestones. Soft clay, shales, slates, and rocks of a similar nature that yield under pressure will not support themselves and require temporary artificial support. Crystalline rocks that have been altered by kaolinzation or similar action are structurally weak and usually require support. Orebodies may be structurally weak or structurally strong. They present a wide variety, ranging from soft to hard, tough material. Walls may be frozen to the orebodies, or a distinct separation may be apparent, sometimes marked by clay gouges. Zones of sheeting, incipient fracturing, and fault zones represent a local weakening of rock structure that necessitates support. As underground water collects in fissure zones, its presence usually denotes areas requiring support.

Several miners' terms afford the basis for a rough classification of conditions—"swelling ground," "loose ground," "weak ground," and "solid ground." Close inspection, sounding with a bar or hammer, and the experience of the miner and his bosses are the criteria by which a given condition is determined. Swelling ground is ground that naturally tends to squeeze into a working, and which thus exerts distinct pressure. Loose ground will not remain in place, but tends to run as soon as an opening is made. Weak ground may or may not stand over a short time interval, and therefore requires the prompt placing of timbers. Solid ground remains standing for a greater or less time interval. It is evident that there are several degrees of solid ground, ranging from that which sustains itself for years or indefinitely to that which may develop weakness in several months.

Changes due to atmospheric action sometimes occur on the exposed rock surfaces, and spalling or flaking off of these surfaces takes place. As atmospheric disintegration proceeds, a greater and greater amount of rock is affected. For this reason gunite is often applied

to such surfaces and is effective in reducing atmospheric action to a minimum. Where rocks are under stresses approaching or exceeding the limit of their strength, gunite is of little service in preventing spalling.

All rocks are under stress, and this increases with depth. The mine opening, whether shaft, drift, or stope, disturbs the equilibrium of the rock mass penetrated, and, if the rocks are weak and the stresses due to weight are large enough, closure begins unless supporting structures add sufficient strength to that possessed by the rock mass to overcome the stresses.

It is evident that under certain conditions timber structures will be of insignificant strength as compared with the stresses operating to provoke closure. Under such conditions waste rock filling is the only adequate method of controlling the forces in operation. Rock pillars are also a means of protecting openings, but this expedient is dependent for its success upon the actual strength of the rock, and unless the pillars are proportioned with respect to this strength and to the forces involved their failure is only a matter of time. Fortunately, readjustment of rock masses is usually a slow process, and sufficient warning is sometimes given by the pillars showing signs of weakness. Combination of pillars and waste filling in extensive flat stopes is not favored by mining engineers, for where top pressures are concentrated upon pillars fracturing of the top rock begins at the periphery of the pillar. The preferable practice is to mine out the entire bed or vein and waste-fill progressively, the filling following the mining at as close an interval as possible. This procedure allows gradual subsidence of the top rock without fracturing it at a number of places. Its weight is taken up by the waste fill. Such a condition is met with in the deep South African gold mines.

As an alternative to the support of extensive areas by waste filling, the prompt closure by caving of the top rock is a practice that has been in vogue by the miner for a long time. Fig. 1 indicates the relation between volume of working and volume of caved ground necessary for equilibrium. Restoration of equilibrium by caving is characteristic of retreating methods of mining and top slicing, and occurs in open-stope methods after a varying time interval, dependent upon the self-sustaining properties of the contiguous rocks. The success of closure by cover-caving is dependent upon the top rock fracturing and caving with a fair degree of readiness. If it is strong and resists breaking in detail until large areas have been undercut, then the forces released may be such as to interfere seriously with the progress of mining.

Improved Roof Support of Flat Stopes

In South African gold mines the problem of supporting extensive areas of relatively flat and relatively thin stopes has become a critical factor in mining practice. Pillar support was first used, and it sufficed until greater and greater depths were attained. Next in order was the filling of great areas with tailings, an expensive procedure. Sand filling became accepted practice. However, in the Far East Rand mines, stopes were at first supported by large pillars, 30 by 25 ft., spaced checkerboard fashion, 95 ft. on the dip and 60 ft. on the strike, respectively 120 and 90 ft. on centers. About 14 per cent of the orebody was left in pillars. In actual practice the pillar proportion was 10 per cent. The spaces between pillars were supported by pigsties, 8 ft. square, filled with waste rock.

According to J. D. Marquard, pillars were found to be of service as a "primary support," as pressure upon them was taken up to some extent by their settlement into the soft shale footwall. Marquard states that in the Central Rand pillars were unable to thus function, and in consequence the hanging wall broke up around them, owing to hanging wall "punching"; and trouble resulted—so much so that pillars were abandoned in the Central Rand. The same difficulty was experienced on the East Rand, where quartzite footwall was found. Pigsties and rock packs were placed closer together in such situations. Marquard states that a filled pigsty is a good support when properly constructed of good timber and properly filled. Bad construction, inferior timber, and breaking up by blasting result in the majority of pigsties failing to develop initial resistance. As they compress the resistance builds up, and often maximum resistance is reached only when they are compressed to 50 per cent of their original height but long before the cohesion of the hanging wall has been destroyed. Marquard brings out the important point that pigsty support does not offer uniform resistance to the downward thrust of the hanging wall, and as a consequence roof

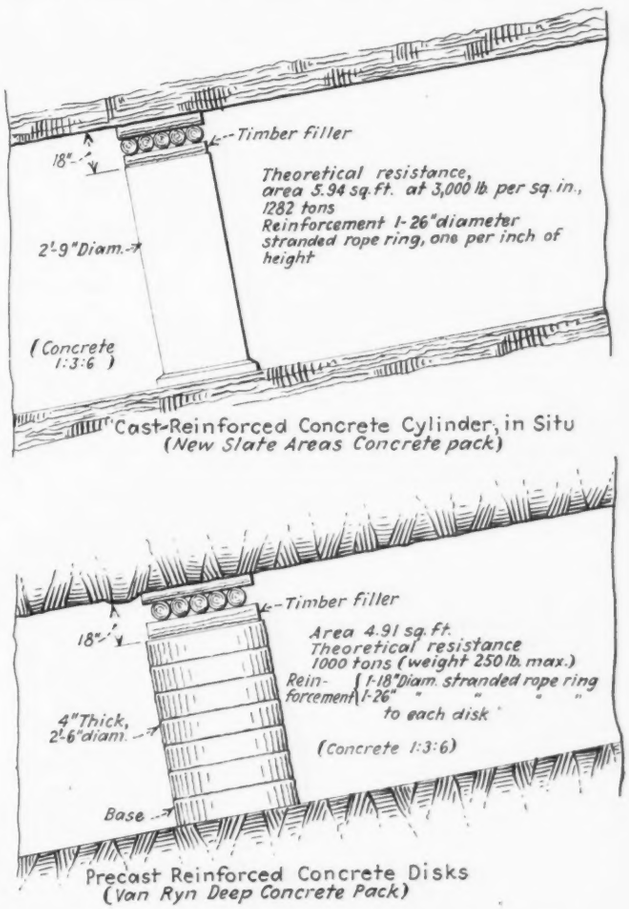

Timber filler
18"
Theoretical resistance, area 5.94 sq.ft. at 3,000 lb per sq. in., 1282 tons
Reinforcement 1-26" diameter stranded rope ring, one per inch of height
2'-9" Diam.
(Concrete 1:3:6)
Cast-Reinforced Concrete Cylinder, in Situ
(New Slate Areas Concrete pack)
Timber filler
18"
Area 4.91 sq. ft.
Theoretical resistance 1000 tons (weight 250 lb. max.)
Reinforcement 1-18" Diam. stranded rope ring
1-26" " " " " to each disk
4" Thick, 2'-6" diam.
(Concrete 1:3:6)
Base
Precast Reinforced Concrete Disks
(Van Ryn Deep Concrete Pack)

Fig. 2—Concrete supports used in stopes on East Rand, South Africa

breaks develop and often extend up to the stope faces.

As an alternative for secondary supports, J. S. Ford in May, 1924, built first five concrete pillars capped with timber in a stope in the New State Areas mine for

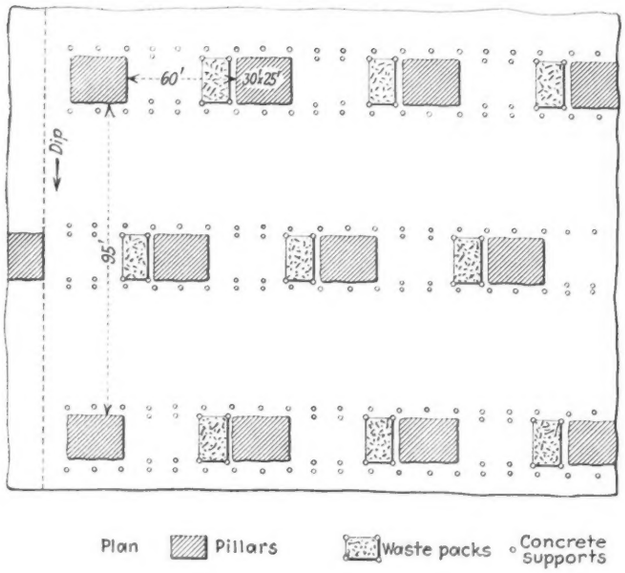


Fig. 3—Sketch showing method of support in New State Areas mine

Pillars are 30 by 25 ft.; concrete supports with timber cushion, 2 ft. 9 in. in diameter; waste packs join four concrete supports. Concrete supports are built 2 ft. on either side of track and spaced 12 ft. apart. Waste is packed at pillars to provide for their subsequent removal; alternate sets of four concrete supports are joined with waste on line of pillars. Concrete supports are 14 ft. 9 in. on centers. Pillars support 14 per cent stope area; concrete supports about 3 per cent; one stone wall on protected side of pillar gives 8 per cent support; stone walls on line of pillars joining consecutive sets of four concrete supports give 15.75 per cent support.

trial, and the outcome was so satisfactory from both cost and roof support standpoints that concrete-timber supports were adopted in 1925. The supports (see Fig. 2) are circular in section, two to four feet in diameter, and have wooden chocks about 18 in. high between their tops and the hanging walls. The concrete cylinder is reinforced with stranded wire-rope rings 2½ ft. in diameter, one ring per inch of height. The top of the concrete is finished off on a plane parallel with the hanging wall. Sheet-iron forms are used, and these are set about 4 deg. from the vertical, and where the footwall dips over 6 deg. a footing is cut. Chocks are placed in position forty-eight hours after placing the concrete.

At the Van Ryn Deep, instead of casting concrete *in situ*, concrete disks 30 in. in diameter by 4 in. in thickness with a center hole 4 in. in diameter are made in a plant at the surface and, after proper seasoning, are transported underground. A. E. Payne states that a base of concrete is made *in situ*, just thick enough to level off the footwall, and one "pancake" is set at the correct angle on this base while it is still soft. This is left for a day, and then the remaining disks are stacked up, a little cement slurry being placed between each and the column built up to within 12 or 18 in. of the hanging wall. Lagging is then wedged in between the top of the pack and the hanging wall.

At the New State Areas mine, pillars (see sketch, Fig. 3) representing 10 per cent of the area and concrete supports representing 3 per cent of area are used. At the Van Ryn Deep a concrete support is used, one to every 7 or 8 fathoms, 252 to 288 sq.ft., in addition to the pillars. Marquard states that in certain mines he believes that one concrete support, 4 ft. in diameter, per 4 fathoms stoped, will permit of the abandonment of pillars altogether. Concerning conditions in some stopes, he says: "In one particular stope in the New State Areas, which was supported with pillars and concrete, one per 8 fathoms, I noticed fairly heavy movement as the pillars were reclaimed and the hanging was changed from a dormant to a live state, so much so that quite a number of 'concretes' started to crack up. (Examination proved that some of these concretes were among the first to be constructed in the mine and showed faulty construction in many cases.) No pillars were lost in this stope; all were extracted, and even sweeping was fairly effectively done after such extraction. I considered that if no pillars were cut, and the concretes were put in 1 to 3 fathoms, the stope would still have been practically intact. Concrete supports act thus under pressure: firstly, wooden chocks compress very much; secondly, concretes tend to punch shale footwalls; thirdly, concretes start to crack near the perimeters; fourthly, shaling starts until top ends get smaller or break away conically; fifthly, concretes collapse and hanging advances quickly. Nowhere have I seen the hanging in mass reach the footwall; it generally rests on the bases of the broken concretes, and I think it will take a long time before such bases actually crumple or collapse."

This interesting adaptation of concrete and timber is important, and great credit is due the underground men who worked out the methods[1] just described.

Support of Openings of Restricted Cross-Sections

Underground openings fall into two general classes, those of restricted cross-section and those of relatively large and irregular cross-section, as in the case of stopes. In the former are included shafts, stations, crosscuts, drifts, raises, and adits. It is a general principle that the more restricted in cross-section an underground opening is, the easier it is to maintain and to support, and, per contra, the larger the cross-section, the greater the difficulty and the more elaborate must be the structure.

The shape of the cross-section is a factor. In the instance of shafts a circular section is the nearest approach to a self-sustaining section, and where concrete is used as a lining the concrete is in compression. Rectangular sections for shafts are widely used, and where concrete is used for lining, reinforcement is necessary, as the structural members must serve in dual capacity, as beams and as struts. In like manner shaft timbers also must be of sufficient cross-section to function both as beams and struts. The rectangular section is best adapted to the use of timbers or structural steel and the circular and oval shaft sections to masonry support. In solid rocks there is little side thrust on the walls of a vertical opening, such as a shaft, but in loose rock and in swelling ground the side thrust is increased and reaches a maximum in soft, yielding rocks. As a shaft may penetrate several different types of rock, the supporting structure may be varied to suit the several conditions. Heavier timbers, more closely spaced, are placed in the zones of loose or swelling ground, or reinforced concrete may be used at these points. Shafts are in numerous instances the principal working entrances to the mine, and special care is taken to insure their permanence. Concrete collar construction is usual at the top section, and best practice indicates a concrete lining throughout, as this construction is fireproof and usually entails minimum maintenance. However, timber

[1]See Journal of C. M. & M. S. of South Africa, July, 1926.

construction is often less in first cost and is therefore largely used in the initial stages of a mine's history or until such time as development indicates sufficient tonnages to warrant more satisfactory construction. It is, moreover, of special utility where earth masses are more or less active.

In timber construction, the weight of the timbers is in part carried by hangers which are supported by the collar set (the topmost set), and at intervals (50 to 250 ft.) bearing timbers are placed across the shaft section to take up the weight of the timbers above and to carry the weight of the timbers below until the next set of "bearers" is in place. In like manner the weight of a concrete lining is supported upon bearers which may consist of concrete corbels or, in a few rare cases, heavy steel pins set in drill holes. The bonding of the concrete with the rough surface of the rock walls is, however, usually sufficient to take care of the weight of the lining except where the rocks are soft and weak. Concrete is placed in sections, each section being built in smaller rings from the bottom of the section up to the finished section above. Collapsible steel forms are used in circular shaft sections. In shafts of rectangular section precast members may be used or the lining and the compartment dividers may be cast in place. In the latter case the amount of concrete will be increased over the minimum established by the thickness of the lining, owing to overbreakage in the shaft section. In the case of precast shaft members, additional concrete is required at the corners and centers of shaft members, but the total is somewhat less than for a monolithic lining.

W. V. De Camp has described a form of reinforced concrete lining consisting of sections of concrete "rings," each 2½ ft. high, separated by exposed wall rock 3½ ft. high. This reduced the amount of concrete and resulted in a saving in footage costs. The ring method entailed a cost of $61.30 per cubic yard of concrete poured (1-2-4), and the monolithic $58.80 per cubic yard, and the saving by the former method was $87.80 per foot of shaft 13 ft. square inside the rings.

It is of interest to note that the timber structure or the concrete lining in a vertical shaft serves a dual purpose: the support of weak portions of the walls and the holding in place of loose rock, and the support of the guides and shaft accessories.

Raises for development and stoping are usually supported by square-set timbering (in weak ground) or simply by stulls (in solid ground), which serve to carry the working platforms and to divide the manway from the waste-rock transfer. Winzes may be supported by shaft sets.

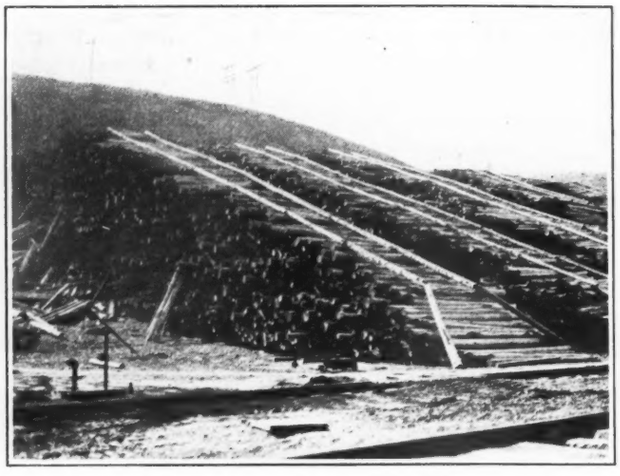
Inclines bring in another factor—the support of the back or upper bounding surface. Where firm, solid rock, not affected by the atmosphere, is penetrated, timbering is omitted and a light structure for the support of shaft accessories is installed. A weak or fissured back necessitates support either by timbering or by reinforced concrete. The sets are placed normal to the axis and are similar in design to shaft sets. Where the angle of inclination is low, the design of timber structure is modified and is similar to that used in drifts and crosscuts. This also applies to concrete structures.

Transfers used for moving ore or waste by gravity from an upper to a lower level are, where possible, driven in hard rock and, when finished, are stripped of timbers required in raising. They usually need no support, but where only soft rock is available the walls must be proctected from wear, and cribbing is frequently applied for this purpose. Timbers are also sometimes protected by steel rails or by steel sheets, especially where the ore stream impinges against the walls. Ore passes which serve a similar purpose, but which are progressively extended up through waste fillings, are also constructed of cribbing protected by one or more layers of planking on the inside and also by a single layer of planking on the outside.

Drifts, crosscuts, and adits present similar conditions. In solid rock free from tendencies to weather or to move, no support is required. In weaker rocks or where local weakness occurs timber or other supporting structures are necessary. The life and purpose of the working determine the selection and design of the supporting structures. In incidental exploration workings, the section may be restricted to 4x6½ ft. and the top arched, timber sets being used at the worst places. Ordinary drifts may be 5x7 ft. in section, with trapezoidal sets at 5- or 6-ft. centers, solid lagging at the top, and spaced lagging at the sides, timber sizes ranging from 6x6, 8x8, 10x10, or 12x12 in. in section and lagging from 2x12 in. by 5 ft. to 3x12 in. by 5 or 6 ft. In heavier ground the sets are more closely spaced, at 2x4-ft. centers.

In wider or double-track drifts, heavier timbers, more closely spaced, are used and are often reinforced with knee timbers. Stations which are from 12 to 18 ft. in width are supported by sets at from 2 to 4 ft. apart. Three- to five-piece segment frames or three-piece rectangular sets with knee braces and sills are used. Concrete is sometimes used in precast reinforced members which are designed along the lines of ordinary timber sets and used in practically the same way, and as a monolithic lining from 6 to 15 in. thick, cast with forms in place and with the upper part of the sections arched, a semicircular arch on narrow openings and a flatter arch on wider openings. Both are reinforced. Openings in solid rock which tends to disintegrate under atmospheric action can sometimes be adequately protected by a layer of gunite. A timbered adit can be made fireproof

Crib supporting heavy ground



Timber yard of large mine

by a gunite coating applied to the timbers over chicken-wire netting. It is necessary to pretreat the timbers with preservatives, as the gunite coatings do not protect the timbers from dry rot.

Pneumatic placing of concrete has materially cheapened concrete lining in adits, stations, drifts, crosscuts, and inclines. By means of the pneumatic gun and 6-in. pipe, according to C. A. Robotham, concrete can be conveyed a distance of 2,500 ft., but more than this limiting distance involves excessive air consumption. Arched forms are more expensive to construct than a rectangular cross-section with heavy filleting at the upper corners. Necessarily, a greater amount of steel reinforcement is required than for the semicircular and flat arches. In work done at the Ray mine (Arizona) a 7 by 8 ft. 6 in. (inside dimensions) arched section costs $52.41 per foot, equivalent to $24.75 per cubic yard of concrete placed (C. A. Robotham). Costs as low as $22 per cubic yard of concrete were obtained.

Pump chambers are supported by fireproof material wherever practicable. Steel, concrete, or reinforced concrete are the materials used, but concrete and reinforced concrete are preferred. However, many pump chambers are supported by timber sets, chiefly from cost considerations, and these may or may not be fireproofed. The tendency of practice is to make pump-chamber structures fireproof if timber is used.

Composite Structures

Combinations of side-rock pack walls with cross timbers (caps) and pole lagging, and concrete side walls with steel "timbers" either of H- or I-beam section, are occasionally used. In permanent haulageways in coal mines steel "timbers" for top support have proved satisfactory where corrosion by seepage water is not a factor of moment. Steel sets are also employed in such haulageways. At intersections where the increased span would necessitate the use of heavier timbers, the steel set constructed of either I-beams or preferably H-beams is frequently substituted for timber sets. Steel I-beams on reinforced concrete posts (precast) are sometimes used in important adits. However, steel is sparingly used underground, and usually only where dimensions can be standardized and where all shop work can be done above ground. Between all-steel and reinforced concrete the latter is preferable from the standpoint of cost and where permanence is an essential. All steel supports are open to the objection of corrosion, which is an uncertain factor, depending upon the immediate environment of the steel.

Support of Stopes

Orebodies vary in shape and major dimensions and present a variety of wall and ore-mass conditions. Stopes or working chambers can be restricted to certain limiting dimensions. A series of stopes may thus be arranged to mine the ore deposit in consecutive blocks.

The three geometrical relations—thickness, dip, and extent—are important; as, for example, a thin orebody of small areal dimensions can usually be removed without leaving a cavity that requires support, but, on the other hand, a thick deposit of extensive areal dimensions would necessitate careful consideration of the mining method and the support required. In general, a deposit of restricted dimensions does not entail as much difficulty as a deposit of great extent and thickness.

Flat stopes opened out extensively reach limits when the top rock begins to take weight or becomes alive and eventually caves. In such workings ore pillars or systematic stull timbering is necessary, but even with these expedients too great an open area may produce a general failure of the roof. It is for this reason that either waste filling is resorted to or the top rock is brought down and the worked-out area closed. Fig. 4 shows various methods of support used in flat stopes. Assuming a vertical stope, the walls tend to fail by first buckling and then caving when too large an open area is maintained. Stull supports will restrain these tendencies, but here again the extent of the opening on the strike and dip are controlling factors. Systematic waste

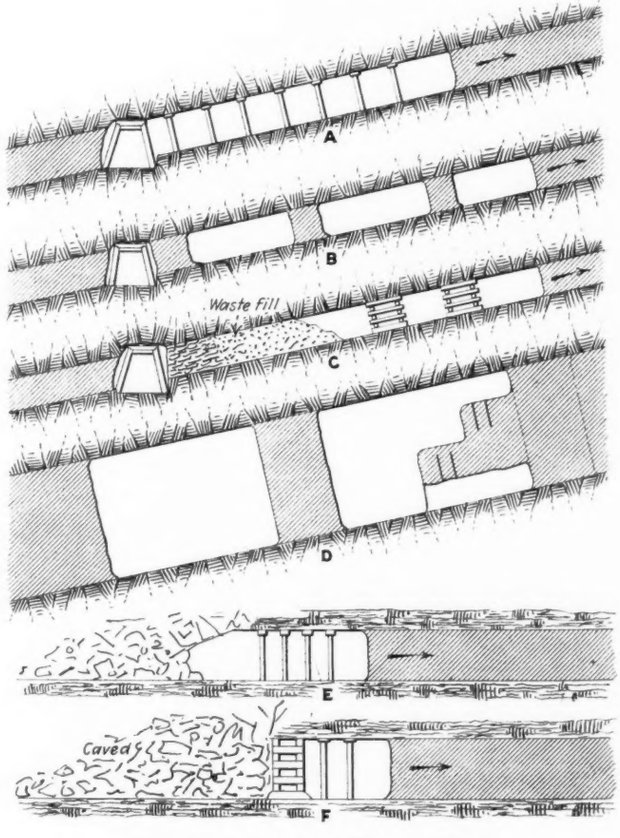


Fig. 4—Support of flat workings

A, by props and head boards; *B*, by pillars; *C*, by timber cribs and waste filling; *D*, by large pillars in thick orebodies; *E*, longwall working; *F*, by breaking and caving top rock.

filling enables control of the situation to be maintained. Pillars and ribs left at regular intervals constitute a form of support of greater aggregate strength than stulls and one that is frequently applied where open stopes are to be left after the ore has been removed.

A simple classification of ore deposits is given in the following:

I—Thickness of orebody:
- (1) Thin—up to 16 ft.
- (2) Thick—16 to 40 ft. or more.
- (3) Of great thickness—100 ft. or more.

II—Dips and extent:
- (1) Dip 0 to 10 deg.
  - (a)—Restricted areal dimension.
  - (b)—Of great extent on dip and strike.
- (2) Dip 10 to 60 deg.
  - (a)—Restricted on strike and dip.
  - (b)—Restricted on strike and extended on dip.
  - (c)—Of great extent on dip and strike.
- (3) Dip 60 to 90 deg.
  - (a)—Restricted on strike and dip.
  - (b)—Restricted on strike and extended on dip.
  - (c)—Of great extent on dip and strike.

The physical nature of wall rocks and ore mass is most important. If both are characterized by fracture planes, gouges, and other evidences of weakness, timbering is indicated for the support of openings. If both are homogeneous and free from incipient weakening, the use of timber can often be avoided or minimized in quantity. The dual purpose of stope supports, to restrain rock from movement and to provide working platforms, must not be overlooked.

Mining methods fall into several broad groups: (1) underhand, overhand, and rill stoping; (2) shrinkage stoping, sublevel stoping; (3) top slicing; (4) sublevel caving and undercut caving. Each of these groups has a more or less well-defined standard of timbering.

Underhand stoping (Fig. 5, A, B) presupposes a strong ore mass and strong walls. Where the orebodies are continuous along the strike the stopes are separated by vertical pillars or ribs parallel to the dip. Levels in the case of steeply inclined orebodies are protected by longitudinal pillars or ribs. Narrow orebodies admit of considerable extension of a stope along the strike, but thick orebodies require shorter stopes. A weak ore mass and weak walls are unsuitable to the method. However, in some underhand stopes regularly spaced stulls are used to support the hanging wall, and the top of the stope may also be timbered.

Overhand and Rill Stoping

Overhand and rill stoping (Fig. 5, C, D, E, F, G) afford a variety of methods of support. Both are restricted to steeply inclined orebodies. A strong ore mass and walls may admit of a horizontal cut-and-fill stope without timbering, but, except in the case of narrow orebodies, the undercut area in the stope is restricted to a certain maximum. As an example a 50-ft wide orebody may be restricted to a stope length of 100

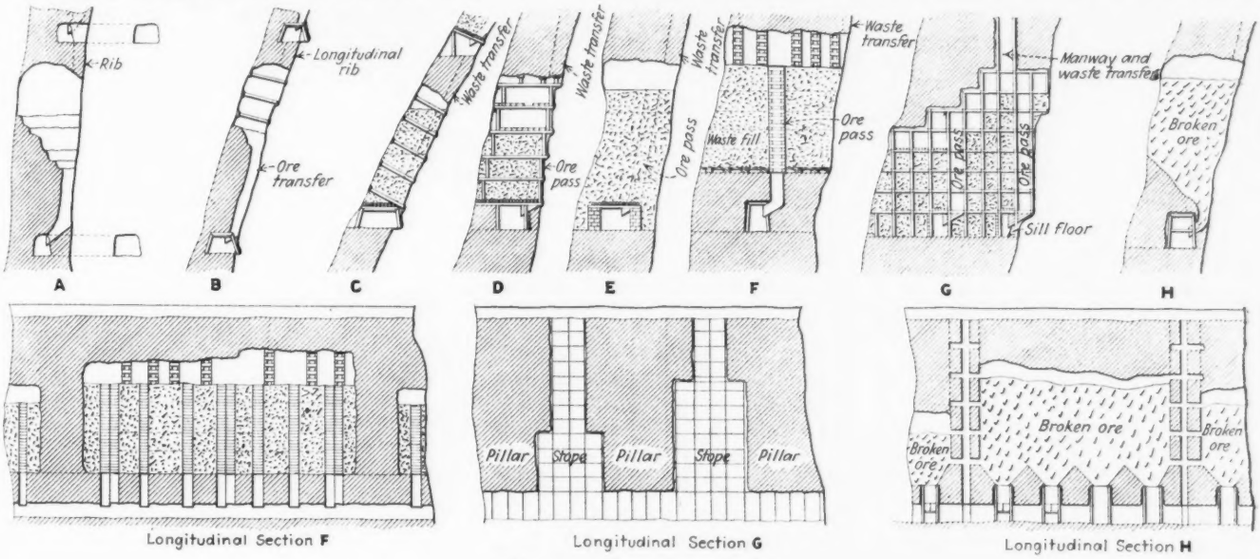


Fig. 5—Mining methods

A, *B*, underhand stoping; *C* and *D*, overhand stoping in stull supported stopes; *E*, flatback and fill stoping without timbers; *F*, flatback and fill stoping with timber crib supports; *G*, square set and fill stopes; *H*, shrinkage stope supported by broken ore.

or 150 ft., giving an undercut area of 5,000 and 7,500 sq.ft. respectively. A hard, tough orebody and good walls may admit of an undercut area of 20,000 sq.ft. or more. It is difficult to lay down any precise rule, but "the wider the orebody the shorter the stope length" is a general principle to be followed. In wide stopes timber cribs are used in horizontal cut-and-fill stopes to support back areas that are locally weak. Open stopes are precluded except for narrow orebodies of restricted length. In almost all cases of wide orebodies, where the strike length is several hundred feet or more, stopes are separated by vertical ribs and the undercut area is reduced to a given maximum. The rill stope is from practical considerations restricted to a length of 50 ft. or thereabouts. The projected undercut area is therefore relatively small. Rill stopes are in the case of weak walls timbered with stulls or square sets.

Narrow orebodies with weak ore mass and walls are timbered with stulls and are progressively filled. The limiting width for stull timbering is roughly 16 ft., but by butting two stulls together at the center greater widths up to 32 ft. are sometimes handled, as in the case of the Hecla mine. Accessory timbers, posts, and collar braces are used with stulls where the walls are weak, and they serve the purpose of more securely fixing the stull in position. The use of head blocks on the hanging-wall end of the stull is resorted to where walls tend to buckle or develop general pressure.

Although stull timbering has been used in horizontal

cut-and-fill stopes (Fig. 5, C, D) up to a width of 32 ft., where walls are of intermediate strength, square-set timbering with waste fill is more suitably applied. Stoping units with square-set timbering are restricted in

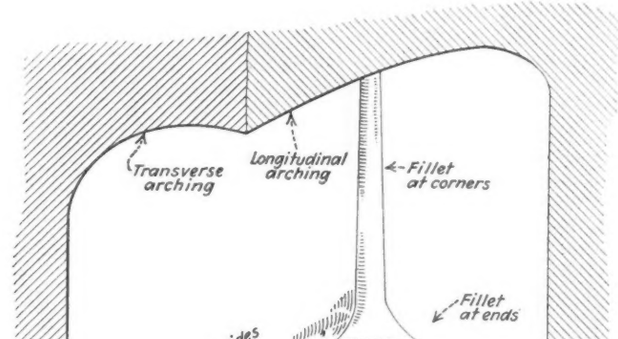


Fig. 6—Sketch showing arching of top and filleting of corners, ends and sides of shrinkage stope

areal dimensions where control of the ground becomes difficult. A unit two sets wide and 10 sets long, representing an undercut area of about 600 sq.ft., is not uncommon in bad ground. This is increased both in width and length where the ore mass is stronger. The tendency of practice is to change from horizontal to vertical slices where the ore mass is weak. With badly shattered ground the unit is started at the top, which is thoroughly secured, and the slice is worked down, using square-set timbering. Only a comparatively small vertical slice is taken, 50 or 60 ft. in height. When the unit, three or four sets square, is finished, it is waste-filled and a contiguous unit is then started.

A variation from the foregoing is illustrated by the Mitchell stoping method, which is a combination of overhand and underhand stoping. The unit is five sets wide and four to five sets long. An end and two side stopes, one set wide, incloses a center block three sets wide and four sets long. The limiting stopes are extended to the top and the uppermost slice of the included block is mined out, using temporary timbering. The top is then secured by lagging supported on three-piece segment sets and stringers framed into the square sets at the side. The remainder of the included block is underhanded and, when finished, waste filling is run in, most of the stringers used to brace the square sets at the sides being recovered. A decided saving in timber results as compared with normal square-set timbering. The height of the unit mined in this way is 50 to 60 ft., although in good ground a greater height is worked.

Both shrinkage and sublevel stoping were invented to avoid the use of timbering and the construction of working platforms in the stopes. The area undercut and the physical nature of ore mass and walls are important factors in shrinkage stoping. As the stope is usually extended by successive horizontal slices, the stope width depends upon the ability of the ore mass to support itself across the span. The wider the stope and the longer its length, the greater is the stress developed in the back. It is not practicable to use timbering on the ore fill to support the back, as the ore fill is unstable as a result of periodical drawing. Therefore, if the back is characterized by areas of weak ground, the method is inapplicable, although R. A. Kinzie told me about certain stopes in one of the mines of the Alaska Treadwell group where back areas became so dangerous as to preclude drilling. Breaking of ore was restricted to the sides of the stope, the central portion caving up to an equilibrium arch, after which new cuts were drilled and broken at the haunches.

General control is dominated by undercut area. By reducing width and length a maximum undercut area may be reached that admits of safe mining. In extensive orebodies worked by this method, the procedure is to divide the orebody into alternate pillar-and-stope units of prescribed width and length. An unsuccessful attempt was made in the early history of the Alaska Treadwell to carry a shrinkage stope about 800 ft. long and over 200 ft. in width, and subsequently stopes were placed transversely to the walls and restricted to a width of 80 ft., separated by pillars 20 ft. in width. The length of these stopes varied with the width of the orebody. One stope reached a length of 400 ft. It was the practice to fillet the corners and to arch the back of each stope across its width and in some stopes the back was also arched from end to end. In effect a dome-shaped back (Fig. 6) was carried, and its self-supporting property was thereby increased. In the porphyry copper mines, shrinkage stopes were tried first, and experience indicated that by narrowing the stopes to from 10 to 16 ft. they could be driven in the weak rock constituting the orebodies. Although this mining method has been superseded generally by undercut caving, shrinkage stopes are still used to delimit undercutting areas at the sides and are restricted to comparatively narrow widths—6 ft. or even less. In thin orebodies and narrow stopes the length factor is of less importance than under opposite conditions.

Sublevel stoping is on the whole applicable to weaker ore masses than shrinkage stoping, but here again is a well-marked tendency to restrict both width and length of stopes by pillars at ends and sometimes at the sides.

TOP SLICING

Top slicing involves a repetition of mining units of small area and height in a given plane at the top of the deposit. Successive slices are taken in this way from the top downward, the top rock being caved and following down upon a timber mat formed by the accumulation of timbers used in the support of each unit. Practice has evolved several kinds of timbering—three-piece sets, square sets, and props and stringers. Square sets are commonly used in starting the first or topmost slice, as irregularities in the top can be followed more readily. Copper mines use props and stringers, restricting the height of unit to from 9 to 11 ft. In iron mines the three-piece set—two posts, cap, and collar braces—is commonly used. Rooms are driven two or three sets wide and 50 ft. in length. A unit of larger areal extent is common in the copper mines. The unit is mined and

timbered, advancing, and, as soon as completed, it is floored and blasted down. The top of each unit is a mat of varying thickness, which affords adequate protection. Areas of units are reduced to the point where in the time interval required for mining the top pressure will not reach a magnitude such that the supporting timbers will be seriously overloaded. These areas approximate the following: in iron-ore mining, 500 to 750 sq.ft.; in copper-ore mining, 600 to 1,600 sq.ft. Respective cubic contents are approximately 7,500 to 11,000 cu.ft. and 6,000 to 16,000 cu.ft.

Inclined top slicing was introduced at Morenci and at other Arizona copper mines. The Mitchell slicing method combined inclined and horizontal top slicing. Both of these methods were devised to reduce labor in handling the broken ore. Introduction of the power scraper made these methods of less importance and practically eliminated them. In both, props and stringers were used as the principal elements in the timber structure required in working under the timber mat.

Caving and Undercut Caving Methods

Sublevel caving (brow caving) and undercut caving methods, as in top slicing, involve a general retreat from the top downward and a retreat from the boundaries or wall inward on each working slice. In sublevel caving, a timber mat is formed and serves to separate waste top rock from ore and also to protect the individual units from uncontrolled runs of caved top rock. Unlike top slicing the units are only timbered, using three-piece sets (posts, caps, top lagging) in the lower half of the slice, the upper half being retrieved under the protection of the contiguous crosscut. A smaller undercut area than in top slicing is the rule, and the pressure of the timber mat is utilized in caving the upper half of the mining unit.

Undercut caving avoids the use of the timber mat, and apart from incidental use of props in the faces where retreating or undercutting is in progress, no timber is required except in the finger raises, at chute controls, grizzlies, and in the development openings. There is a well-marked tendency to use reinforced concrete on main haulageways and in shaft structures and timber structures on all intermediate development. At Miami and Ray, where hand-tramming drifts are in use in close proximity to the undercutting and drawing operations, retimbering of the tramming drifts is necessary at intervals. In the Morenci inclined undercutting caving method, a comparatively recent innovation in undercut caving, short inclines timbered with three-piece sets and heavy pole lagging are used for drawing caved ore, and timber maintenance appears to have been greatly reduced, as compared to that required in hand tramming drifts and crosscuts in immediate proximity to the caved ore mass.

Inspiration first introduced high lifts in undercut caving by increasing the vertical caving interval from 75 to 90 ft. up to 200 or 300 ft. This reduced the amount of intermediate development as compared to the practice at Miami and Ray. In later work at Miami, Inspiration practice of winning the orebody in one lift was adopted.

Top slicing and caving methods are predicated upon the breaking up and subsidence of the overlying top rock. The extent to which the surface is affected is an important factor. In general, the surface area affected is greater than the area of the orebody. Angles of break starting out from the periphery of the orebody vary from a minimum of 40 deg. up to 70 deg. or more. The nature of the top and side formations, the depth and thickness of the ore mass, and the surface contour are factors influencing the angles of break. Softer rocks result in lower angles of break. Stronger and more homogeneous rocks may be expected to result in a smaller area of surface subsidence than the area of the orebody only where the orebody is at considerable depth and the ratio of ore to overburden is relatively small.

Sublevel caving and undercut caving are applicable to low-grade orebodies weakened by fracture planes and alteration. Such orebodies could not be economically mined by timbering and waste filling or by the customary methods employed for smaller and richer orebodies. To contrast conditions it is only necessary to cite the instance of the United Verde mine, where large massive pyrite-chalcopyrite orebodies of great structural strength with good walls are being mined by horizontal cut-and-fill stopes, whereas large orebodies of very much lower-grade ore and with ore of much less structural strength are being mined by undercut caving at Inspiration, Miami, and Ray. At the Bunker Hill and Sullivan mine a good-grade orebody of large size and of intermediate structural strength, with weak walls, is being mined by square set and fill.

Connecting Stopes

To finish a horizontal cut-and-fill stope or to bring a shrinkage stope through to the level above involves the removal of a horizontal slice of ore above a waste fill and beneath a waste-filled stope. At the United Verde mine the practice is to finish stopes by square set and fill, retreating from one end of the horizontal slice to the other. Manways and ore passes in the filled stope are utilized for access and ore disposal. At the Homestake mine, shrinkage stopes are drawn and waste-filled, and the stope ribs or arches are removed by overhand stoping with square-set timbering.

Reducing Maintenance Costs

The position of the stope sill floor relative to the level in overhand stoping in wide orebodies (waste-filled stopes) admits of several possibilities. In former practice (and this is to some extent still followed) stopes were opened out and the waste fill was started on the plane established by the level. This necessitated heavy timbering on the gangways and the use of a heavy timber floor above the gangway timbers. As these structures were inclosed by a waste-rock fill on sides and top, it necessarily followed that maintenance of the timbered structure was an important item of expense during the life of the stope. To minimize the maintenance expense, sill floors were started just above gangway timbers, leaving the gangways protected on both sides by undisturbed ore. A further improvement placed the sill floor a short distance above the tops of the gangways, leaving the latter in solid ground on all sides. This reduced timber maintenance to a minimum. The ore thus left in place is won by continuing stoping operations from the lower stope. To facilitate mining under the filled stopes, a plank flooring is laid on the sill floor before beginning the waste fill.

Likewise in shrinkage stoping examples of timbered bottoms and gangways are occasionally found, but the expense for these structures can be reduced by placing

gangways and chute raises in the solid and starting the shrinkage stope 25 or 30 ft. above the level. Where shrinkage stopes are waste-filled with the objective of mining the horizontal rib, a timber floor or a mat of refuse timber is put in place before waste filling is run in.

DRIVING IN LOOSE GROUND

Spiling or forepoling continues to be the chief method of ground support where loose ground is encountered in drifting and crosscutting. There is a tendency to use steel hangers and H-beams in place of the boom and post to support the top boards while they are being driven to their positions. This arrangement gives the maximum amount of room at the face and saves the time required for the placing of a false set, which was used at one time. In loose-ground work, the smaller the section the less is the load necessary to support. Caps are shortened by increasing the batter of the posts. Spiling is used in stoping where top and sides are fissured and broken, approximating loose-ground conditions. Here also the boom or cantilever is used to catch up the overhanging spiles or poling boards while they are being driven to position and while the loose ground is being excavated to provide room for the advance set.

Caved ground in stopes entails special precautions in recovering the stope. The logical procedure appears to be to start in the solid on one side of the cave and open out a vertical slice, securely timbering it with posts and stulls or square sets. The advance is made into the caved area at the top, which is supported by spiling resting upon booms carried by the timbered slice. The tap is secured and the first unit timbered, the timbers being temporarily carried also on booms (cantilevers). The slice is then worked downward, main timbers being placed successively and all being partly supported by booms bearing upon the solid timber structure already in place and by blocking to the walls. By a series of successive vertical slices the caved ground is worked out and the stope recovered. Waste filling is used to fill the vertical slices when they are finished. One of the best descriptions of caved ground operations is given by Claude T. Rice[2], who described in detail the practice developed at the Hecla mine.

THE JACKET SET

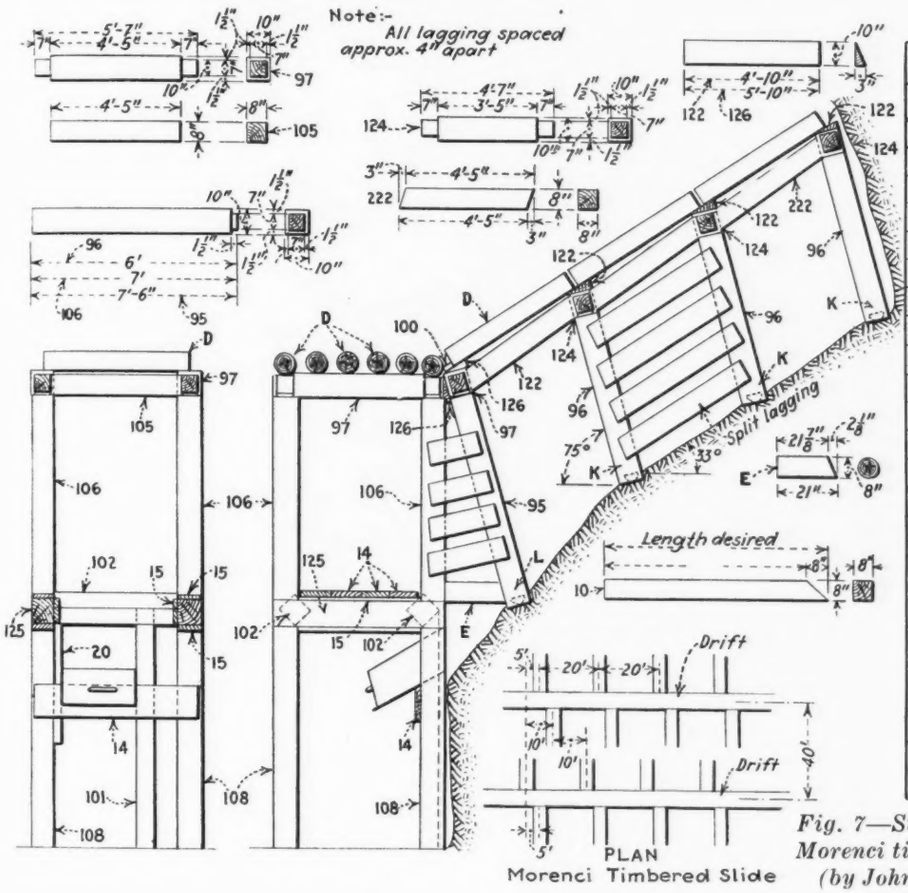
Shafts, stations, and more or less permanent openings in moving or swelling ground are generally troublesome unless supporting structures are sufficiently strong to resist the maximum pressures. Such structures are generally too expensive to use except in very important openings, and in their place timbering is commonly used. The miner "eases the ground" by removing a portion of it from behind lagging and timbers from time to time. To facilitate this, outer or supplementary sets, jacket sets, are placed in drifts, crosscuts, and also in shafts. The extra space affords working room for easing the ground and replacing broken lagging boards and timbers without interfering with the use of the opening. A variety of design is found in these supplementary or jacket sets. However, in most instances an outer set duplicating the members of the inner set is provided and the working space is maintained by short-distance pieces or props, which throw the important reactions upon the caps and posts in the case of the drift set and upon the wall and end plates of the shaft sets.

[2]*Engineering and Mining Journal*, Vol. 106, p. 1, July 6, 1917.

When rock is broken into a relatively large number of fragments its volume is increased about 50 per cent, or one cubic foot in place will swell to 1.5 cu.ft. when broken up. On this basis, if the roof above a working area 10 ft. in height is broken down pretty thoroughly, some 20 ft. of solid above the working will supply sufficient volume of broken rock to fill the mined-out area and the space formerly occupied by the solid rock. The degree to which the overlying rock is broken and jumbled up will determine the amount of surplus volume derived from a given vertical range of roof rock. No precise determinations of the extent to which top rock will break up have been made so far as my information goes, but undoubtedly there are numerous cases where the breaking up results in the maximum increase in volume. Assuming that there is a variation from this maximum, I have plotted a series of curves representing the relation between height of working and the height of solid ground that will be necessary to fill not only its own volume but also the volume represented by the workings. These are shown in Fig. 1. It is evident that, if mined-out areas are completely filled with broken rock, subsidence of the overlying formation will occur only as the loose rock consolidates. Undoubtedly, shrinkage does take place, especially with soft, yielding rocks. With harder rocks the time during which such settlement will take place will be greatly increased compared with that when the overlying rocks are soft and yielding under their weight and that of the overlying strata. More or less subsidence takes place over any mined-out area, but whether this reaches the surface or not depends upon numerous uncertain factors peculiar to each operation. Observations made upon a number of cases yield anomalies which preclude definite conclusions respecting the height and the surface area included in the subsidence above the mined-out area. It is evident that when the hanging-wall rock mass above inclined workings moves en masse or in comparatively large blocks, subsidence and fracturing may extend over a larger area than the projected area of mine workings. H. G. Moulton suggests, that "in planning the development of underground operations involving stopes of large area and considerable depth, slopes of approximately 70 deg. (½ to 1) should be projected upwards from the location of the outer boundaries of the stopes at controlling points and lines drawn connecting the intersections of such stopes with the surface." He states further: "Within these lines will be contained the entire area of ground that will be disturbed by settlement cracks resulting from subsidence over the stopes, providing the rock is fairly homogeneous and there are no extensive fault planes or contacts between rocks differing greatly in hardness."

In mining practice exceptions to Moulton's generalization have been noted. J. Parke Channing cites examples in the case of the Miami mine, where the plane angle of outer fractures at the surface ranged from 42 to 50 deg. However, it was noted that in general the area of subsidence was about the same as the area of the horizontal projection of the largest dimensions of the underlying orebody. The subcommittee on coal mining of the Institute reported its conclusions relative to subsidence over coal-mining workings, which are briefly summarized as follows: In mine areas subjected to a squeeze and from which pillars have not been removed subsidence is over the mined-out area. In one case of a coal seam dipping at an angle of 30 deg.,

the extreme crack indicating surface disturbance was ahead of a vertical line from the face but back of a normal line to the seam. Relative to the effect of working a seam of coal contiguous to a coal seam above, which is to be subsequently worked, the committee



TIMBER SCHEDULE

No.	Amt.	Name	Dimension	Description	Bd.Ft.
108	4	Post	10"x10"x7'-6"	Square Ends	250.0
106	4	Post	10"x10"x7'-0"	See Detail	233.3
95	2	Post	10"x10"x7'-6"	See Detail	125.0
96	6	Post	10"x10"x6'-0"	See Detail	300.0
125	2	Cap	10"x10"x5'-10"	Square Ends	97.2
97	3	Cap	10"x10"x5'-7"	See Detail	139.5
124	3	Cap	10"x10"x4'-7"	See Detail	114.6
102	2	Brace	10"x10"x4'-2"	Square Ends	69.4
105	2	Brace	8"x8"x4'-5"	Square Ends	47.0
222	6	Brace	8"x8"x4'-5"	See Detail	151.8
101	1	Post	8"x8"x Length desired	See Detail	40.2
15	6	Scab	2"x10"x4'-10"	Square Ends	41.4
122	3	Scab	3"x10"x 4'-10"	See Detail	42.2
126	2	Scab	3"x10"x5'-10"	See Detail	31.5
20	1	Scab	3"x10"x 4'-10"	Square Ends	10.0
14	1	Scab	2"x12"x 5'-10"	Square Ends	11.6
14	4	Plank	2"x12"x 5'-10"	Square Ends	46.6
D	21	Lagging	8"Rnd.x 5'-0"	Square Ends	439.7
E	2	Brace	8"Rnd.x 2'-0"	See Detail	16.7
L	1	Brace	Split 4'-2"	Square Ends	4.9
K	3	Brace	Split 3'-2"	Square Ends	11.2
–	12	Split Lagging 5' Long		–	64.3
100	1	Sab	2"x4"x 5'-10"	Square Ends	3.9
				Total Board Feet	2,291

Fig. 7—Standardized timbering design for Morenci timbered slide undercutting method (by John Martin and Leslie MacDougall)

states that mining an upper seam after a lower one has been removed can almost always be successfully done when the thickness of the intervening strata is 19 ft. or more, the thickness of coal mined in the lower seam not exceeding 8 or 9 ft. According to the committee, the lower seam should be entirely removed from any area, and time should be allowed for settlement before working is started in an upper seam. Also, working in an upper seam should not be attempted while pillars are being extracted in a seam below it.

Relative to subsidence resulting from room-and-pillar working, the committee reports that in the majority of cases the subsidence was over the mined-out area. Exceptions to this involve conditions peculiar to the particular operation. Subsidence due to long-wall mining almost always extends beyond the limits of the mining area and appears peculiar to this method of mining.

G. S. Rice in 1923 brought out a similar set of conclusions. The subject as a whole has reached a stage where a thorough investigation should result in a formulation of definite principles reconciling theory and observation. The metal miner is, however, not so greatly concerned about surface subsidence, but in so far as surface structures may be affected, as in undercut caving, it is essential for him to give some attention to the subject. Likewise, in the mining of extensive sheet-like deposits, such as the South African gold mines and the Michigan copper mines, it is necessary to foresee probabilities of ground movement and its immediate results in affecting mining operations.

The need for greater economy in mining has resulted in persistent study of ways and means of reducing timbering costs. Standardization of timbering practice with the objective of simplification both in type of joints and in dimensions of framed timbers is now common, especially in larger mines. An example of this is afforded by the Humboldt mine, at Morenci, Ariz. A series of standard charts (Fig. 7 is an example of one), one for each type of timber framing, with specified lengths and shapes, has been worked out. Each timber of particular size and shape is given a number. Chute construction has also been reduced to certain standard types and dimensions. Thus the preparation of timbers for the mine is reduced to a system admitting of mass production. Cutting and fitting at the working faces are reduced to a minimum and mining work is simplified by the availability of standards for each situation. Necessarily, mining methods have been systematized as a preliminary to standardized timbering.

Salvaging old timbers, another economy, has always been a more or less supplementary practice, but is limited by individual mine conditions. In most mining methods timber recovery is out of the question. It is more economical to utilize inferior grades of timber where they can be suitably applied than to use good-grade timber for all purposes. Proper storage of timber with the objective of least deterioration during the period of storage is an important factor in promoting economy. Likewise, there are advantages in price and cost of handling where timber supplies are purchased in quantity sufficient for a year's supply.

One of the practices most discussed is the use of timber preservatives. Any procedure that will minimize replacements by prolonging the life of timbers will reduce costs, and therefore timber preservatives have a definite place. However, in stoping and in situations where more or less ground movement takes place, the life of timbers is predicated upon other conditions than their ability to resist deterioration by rotting. Treated timbers are therefore not economical under such conditions. However, mine ties and timbering in adits, shafts, and workings that are to be in use for long periods are best treated with preservatives. A variety of preservatives and methods of applying them are available. R. R. Horner and H. E. Tufft[a] state that, "treatment by pressure usually prevents decay most effectively, but hot- and cold-bath treatment either with coal-tar creosote or zinc chloride greatly increases the life of the timber and gives very satisfactory results." To get the best results in applying preservatives, dry-seasoned timber is necessary. For pressure treatment a more elaborate plant is required than for the simpler open-tank treatments. Steam heating is usually necessary. The capital investment is not excessive even for the pressure-treatment plant, and as a consequence most large mining companies that use quantities of timber have experimented with timber preservatives and in many instances have adopted some form of timber treatment in their mining practice. No long-lived property can afford to neglect careful consideration of this subject.

Another practice which results from a far-seeing policy is the driving of important development workings in either footwall or hanging-wall rocks at a short distance from the orebody. The most stable rock is selected, and it may not be necessary to use timbering in such workings at all, or a lining of gunite may serve to prevent weathering. Not only is there a direct saving in material, but there is also a saving in maintenance costs wherever important development workings are timbered and must be kept open for a period of years.

Batch Process for Electrolytic Separation of Gold from Silver

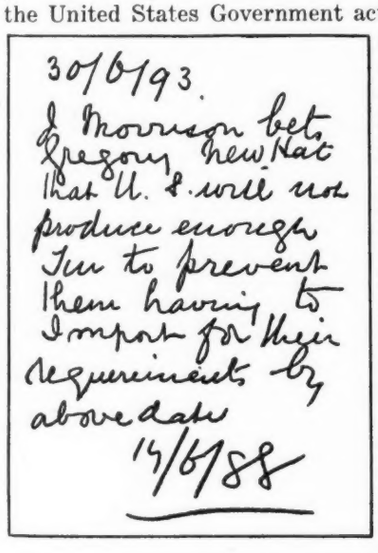
In *British Chemical Abstracts* was recently published a description of a method for the electrolytic separation of gold from silver. [V. A. Vanioukov (*Messager ind. Métaux* [Russia], 1920 [7—8]; *Chem. Abstr.*, 1926, 20, 3269)]. In an improved Balbach apparatus, bars of auriferous silver are placed in wooden tanks in the electrolytic bath in which silver T-shaped anodes are placed over, and in contact with, the auriferous silver, thin silver sheets in the bottom of the bath serving as cathodes. When a bath containing 2 to 4 per cent of silver nitrate and 1.5 to 2 per cent of free nitric acid was employed, the loss of silver was only 0.026 to 0.085 per cent; recovery of the gold was complete. The average current efficiency was 95.04 per cent and the nitric acid consumption 43.15 per cent. During the electrolysis the free nitric acid content of the electrolyte fell from 3.38 to 3.70 per cent to 0.80 to 0.97 per cent, and the copper content increased from 0.69 per cent to 2.39 per cent per batch run of 1 kw.-hr. The original silver content of the electrolyte was 3.13 to 2.28 per cent.

[a] "Mine Timber." By R. R. Horner and H. E. Tufft; Bull. 225, U. S. Bureau of Mines.

An Echo of the Harney Peak Tin Boom

The more or less meager tin deposits of the Black Hills, in South Dakota, are the subject of editorial recollections in a recent issue of *The Metal Bulletin*, of London. "Memory has to be cast back a good many years," says the *Bulletin*, "to recall the great Harney Peak boom in the late 80's, based upon the assertion that the newly discovered Harney Peak mines in South Dakota would supply the United States with all the tin required there. . . . Without going into details as to whys and wherefores, let it be sufficient to say that whatever these mines may have contained, tin was notable for its absence, that the bubble burst, and that the confiding investors got their fingers burnt more or less badly. The belief of the optimists, however, is attested by the accompanying illustration, which records a bet made on the Metal Exchange in June, 1888, and roughly noted in one of the little cash books so commonly used in the olden times.

That Harney Peak was once regarded seriously as a potential tin producer is shown clearly by the fact that the United States Government actually imposed an import duty on tin in order to protect the embryo industry, but subsequently withdrew it when the real nature of the mines stood revealed. It is true that a little tin has been located in the rock formation near Hill City, South Dakota, where the mines were situated, but the quantities produced have been merely infinitesimal. Hope springs eternal, however, and although the bubble burst, the mines found subsequent purchasers. In 1917 they passed into the possession of the American Tin & Tungsten Co., which purchased them from the Hill City Tungsten Producers Co,, and the first-named company in 1919 seems to have leased them to the National Tin Coroporation, of 50 Broadway, New York City, which in 1920 produced twelve tons of concentrates from 800 tons of ore, though whether these were tin concentrates or tungsten concentrates, or a mixture of the two, is not stated. Late in 1922 it seems that the Richards Co., Inc., of Boston, agreed to aid in the development of the property, but the contract was apparently not consummated, says the *Mines Handbook*, because in October, 1923, the National Tin Corporation was negotiating with the Alloy Reduction Co. to smelt concentrates at its Morristown, N. J., plant, while early in 1924 the company was reported to be treating with brokers to take over the market for a block of treasury shares."



Development of these long-known deposits is continuing, in a small way, and until recently at least the stock of the National Tin Corporation had a market, at a few cents a share, on the New York Curb. But J. W. Furness, of the U. S. Bureau of Mines, was well advised when he wrote of tin recently that "so far as present knowledge goes, the domestic resources are negligible."

Obviating the Harmful Effect of Soluble Salts in Flotation

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THAT THE PRESENCE of soluble salts has a marked influence on the flotation of various ores is a well-established fact. The usual soluble salts present in flotation pulps, due to the solution of the inherent salts in the ore or those in the water used, are ferrous and ferric sulphates, manganous and manganic sulphates, aluminum sulphate, sodium sulphate and chloride, and lime and magnesium salts. The influence of the salts of iron and aluminum, and methods for eliminating these effects in the flotation of copper ore have been the subject of an investigation to be summarized here. Further work on lead and lead-zinc ores is contemplated.

Through the courtesy of the Utah Copper Co., a quantity of ore was obtained containing a minimum of non-sulphide copper. This assayed 0.98 per cent total copper, of which 0.03 per cent was non-sulphide copper, the amount of soluble salts in this ore being negligible. Flotation tests were carried on in a laboratory Janney flotation machine. The flotation reagents used were xanthate and Cleveland Cliffs creosote No. 2, these reagents being used in the same quantities in all tests. Chemically pure burnt lime and ferrous, ferric, and aluminum sulphates were also used.

Table I shows the effect of the addition of various amounts of ferrous, ferric, and aluminum sulphates, keeping the lime a constant. Table II shows the effect of increasing the amounts of lime in conjunction with increasing amounts of soluble salts.

Table I—Effect of Addition Agents on Grade of Tailing, Keeping Lime Constant

Reagents: 4 lb. CaO, 0.2 lb. xanthate, 0.5 lb. C.C.No. 2, per ton of ore

Ferrous Sulphate		Ferric Sulphate		Aluminum Sulphate	
Lb. $FeSO_4$ Per Ton Ore	Tailing Per Cent Copper	Lb. $Fe_2(SO_4)_3$ Per Ton Ore	Tailing Per Cent Copper	Lb. $Al_2(SO_4)_3$ Per Ton Ore	Tailing, Per Cent Copper
0.0	0.07	0.0	0.07	0.0	0.07
1.5	0.19	2.0	0.21	2.0	0.10
3.0	0.16	4.0	0.19	4.0	0.12
4.5	0.22	6.0	0.46	6.0	0.17
6.0	0.79	8.0	0.44	8.0	0.21
7.5	0.73	10.0	0.32	10.0	0.42

Table II—Effect of Increased Lime and Soluble Salts on Grade of Tailing

Reagents: X lb. CaO, 0.2 lb. xanthate, 0.5 lb. C.C.No. 2, per ton of ore

Ferrous Sulphate			Ferric Sulphate			Aluminum Sulphate		
Lb. CaO Per Ton Ore	Lb. $FeSO_4$ Per Ton Ore	Tailing Per Cent Cu	Lb. CaO Per Ton Ore	Lb. $Fe_2(SO_4)_3$ Per Ton Ore	Tailing Per Cent Cu	Lb. CaO Per Ton Ore	Lb. $Al_2(SO_4)_3$ Per Ton Ore	Tailing Per Cent Cu
4.0	0.0	0.07	4.0	0.0	0.07	4.0	0.0	0.07
5.0	1.5	0.10	5.0	2.0	0.08	5.0	2.0	0.10
6.0	3.0	0.13	6.0	4.0	0.10	6.0	4.0	0.12
7.0	4.5	0.14	7.0	6.0	0.13	7.0	6.0	0.12
8.0	6.0	0.17	8.0	8.0	0.11	8.0	8.0	0.09
9.0	7.5	0.23	9.0	10.0	0.14	9.0	10.0	0.10

It is evident from Table I that ferrous sulphate, even when present in small quantities, is extremely detrimental and affects copper recoveries to a marked degree. Ferric sulphate is also detrimental, but its effect appears to reach a peak, beyond which copper recoveries are not decreased. Aluminum sulphate is also detrimental, although to a lesser extent than are the iron salts. Table II shows that the addition of burnt lime to a large extent counteracts the harmful effects of ferric and aluminum sulphates; but ferrous sulphate, even when excessive amounts of lime are present, still adversely affects copper recoveries.

With these facts established, it was logical to try next the effect of adding an oxidizing agent and lime to the ore pulp, and then subject this treated pulp to flotation. Experiments were carried out on Utah Copper Co. ore to which ferrous sulphate had been added, and also on samples of ore from the Braden and Chino Copper companies, which contain soluble iron salts. Chloride of lime and oxygen gas were used. The chloride of lime was, with burnt lime, added at the ball mill and the oxygen gas was bubbled through the ore pulp in the presence of lime. Flotation reagents were added in the flotation machine after the oxidizing treatment. Table III shows the tailings obtained, both with and without this treatment.

Table III—Effect of Oxidizing Agents on Grade of Tailing

Test	Lime Lb. Per Ton	Bleach Lb. Per Ton	Xanthate Lb. Per Ton	Frother Lb. Per Ton	Tailing Per Cent Cu	Feed Per Cent Cu
Utah Copper ore and 7.5 lb. $FeSO_4$ No. 1	4.0	0.0	0.10	0.50	0.17	0.98
No. 2	4.0	2.0	0.10	0.50	0.12	0.98
No. 3	4.0	3.0	0.10	0.50	0.09	0.98
Braden Copper Co. ore, No. 1	4.0	0.0	0.20	0.50	0.58	2.34
No. 2	4.0	1.0	0.20	0.50	0.42	2.34
No. 3	4.0	2.0	0.20	0.50	0.44	2.34
No. 4	4.0	3.0	0.20	0.50	0.45	2.34
No. 5	4.0	4.0	0.20	0.50	0.45	2.34
No. 6	4.0	0.0	0.20	0.50	0.35	2.12
No. 7	4.0	2.0	0.20	0.50	0.26	2.12
No. 8	4.0	(a)	0.20	0.50	0.26	2.12
Chino Copper Co. ore No. 1	4.0	0.0	0.10	0.50	0.35	1.53
No. 2	4.0	2.0	0.10	0.50	0.25	1.53

(a) Oxygen used instead of bleaching powder.

Table III shows that by the addition of 2 lb. of bleaching powder, from 1½ to 3 lb. of copper can be saved per ton of tailing produced. The results using oxygen instead of chlorine (bleach) are the same, but bleaching powder is easily measured and controlled. An excess of oxidizing agent is to be avoided, not only on account of its cost, but an excess is detrimental to copper recoveries, probably because of the destruction of organic flotation reagents. The odor of chlorine should be absent when the pulp goes to the flotation machine, and before flotation reagents are added.

The following deductions are drawn from the results obtained:

1. Ferrous, ferric, and aluminum sulphates seriously affect copper recoveries, even when present in relatively small amounts.

2. Burnt lime eliminates, to a large extent, the deleterious effects of ferric and aluminum sulphates, but offsets to only a small extent the effect of ferrous sulphate.

3. By adding an oxidizing agent, such as oxygen, chlorine, or chloride of lime, to the ore pulp in the presence of burnt lime, the effect of ferrous sulphate can be almost completely eliminated.

The Lowest Grade Gold Mine

The Alaska Juneau, says F. C. Lincoln in *The Black Hills Engineer*, is the lowest-grade hard-rock gold mine in the world, though some placer gold mines have operated at a profit on gravels running as low as 5c. per cubic yard, equal to about 3c. per ton. In October, 1926, Alaska Juneau milled 11,932 tons, recovering 50.55c. in gold per ton. Operating costs were reported at 43.8c. per ton, thus leaving an operating profit of 6¾c. per ton, even on such low-grade ore.

News of the Week

Summary

BRITISH COLUMBIA MINES operating at full capacity, with much prospecting and development under way—Vancouver properties attract big operators.

French's patents declared invalid by Canadian court—Abana mines litigation ended—Geological report on western Canada available.

Grasfontein diamond rush—Gold production of Canada increasing—Flin Flon plant started.

Kay Copper dropped from New York Curb—Fatal accident at Junction mine.

Holmes Safety Association awards certificates for safety record.

Bureau of Mines fails to secure additional appropriations by reason of Senate filibuster; co-operation planned with Canada.

Michigan College of Mines becomes Michigan Tech—Nova Scotia to encourage gold mining.

East Geduld shares on market—Silver coinage restricted in Mexico—Nevada-Bellevue leaching copper in place.

South African mineral production gains £4,000,000—Ferreira Deep plans liquidation.

Consolidated Mines Selection has record year—Mining activities in Luzon.

Gilbert Mammoth Elects New Officers and Arranges to Satisfy Judgment

AFFAIRS of the Gilbert Mammoth Last Hope Mines Co., Gilbert, Nev., which owns the original strike in the Gilbert district 30 miles westerly from Tonopah, Nev., appear to have been settled to such an extent that it is hoped the $31,000 judgment will be provided for and development resumed on the property.

At a twice-adjourned meeting of stockholders, held in Tonopah on Feb. 9, a new board of directors was elected, the faction headed by W. C. Lamb, formerly vice-president, losing control. On Feb. 15 the directors met at Gilbert and elected officers for the ensuing year, as follows: Henry C. Cryder, of New York, president; M. L. Beistle, of Pennsylvania, first vice-president; W. H. Thomas, of Tonopah, second vice-president; J. M. Fuetsch, of Tonopah, third vice-president; Arthur Raycraft, of Tonopah, secretary-treasurer; with W. L. Ellis and W. H. Fording as additional directors.

The company has 930,590 shares of its stock in the treasury, and the directors have offered 200,000 shares to present stockholders at 25c. per share, with the provision that if the block is not subscribed by March 19, the unsold balance will be sold to the public at a price to net to the company 25c. per share. This would place $50,000 in the treasury, and after paying the Cryder judgment of $31,000 the company would have remaining but $19,000 with which to resume development work. This would not, of course, be sufficient to carry on an extensive development campaign, but it is not known whether the board contemplates further sale of treasury stock or considers ore shipments will be large enough to carry development expense after the $19,000 is exhausted. The record of the company would not indicate that any substantial revenue could be expected from this source, as ore shipments, considering the time of operation, the extent of development work, and previous extensive advertising, have been negligible. However, in case a body of commercial ore should be opened, the company is in a favorable position to handle it. The ore can be shipped to the mills at Millers and Tonopah. Truck, railroad and treatment rates are not excessive.

The Gilbert situation is an interesting one, and development on other properties in the district undoubtedly depends upon what is accomplished in the Gilbert Mammoth Last Hope mine, which is regarded as a leader. Most of the development in the district has been handled either by practical miners who were forced by circumstances to make returns from ore shipped carry the expense of the meager development work, or by stock brokers and others who knew little about actual mining and were more interested in market quotations on their respective stocks than in a well-directed development campaign to prove the value of their properties. The Gilbert Mammoth Last Hope Co. falls into the last-named class, and though published reports indicated the existence of large tonnages of high-grade ore, only small shipments were made, and the desultory development work was financed through the sale of stock. It is generally believed that the property contains veins well worth development, in spite of the fact that work to date has disclosed only small bodies of commercial ore, and it would seem that a development campaign placed in the hands of a capable engineer might be productive of results, at least giving the district as a whole the hitherto unknown advantage of capable direction of future work on a centrally located property.

Opposition to Resumption of Hydraulic Mining in California

Although any resumption of hydraulic mining in California is several years in the future, and necessarily dependent upon the securing of federal and state appropriations for dam construction, agriculturists in the Sacramento Valley are alarmed and have begun to take steps in opposition to attempts being made to facilitate hydraulic mining revival. The Sutter County Farm Bureau has proposed for adoption by other farm bureaus a resolution opposing any effort to make possible hydraulic mining. The resolutions in question fail to recognize the work accomplished by the California Débris Commission in rectifying the conditions resulting from hydraulic mining years ago. (See page 458, this issue, for commission's report.)

Lead Smelter at Douglas Ready in June

The lead smelter which the Phelps Dodge Corporation is building at Douglas, Ariz., is expected to be completed in June of this year. As planned, the plant will have a capacity of 50 tons of lead bullion per day. The corporation's 150-ton lead concentrator will be ready in April. G. H. Dowell, manager of the corporation's Copper Queen branch, is visiting various mining districts in Arizona for the purpose of locating sources from which the smelter and concentrator will draw custom ore. The concentrator will specialize in treating complex ores, such as lead-zinc-copper ores. Favorable freight rates to Douglas and Bisbee from other Arizona points are now in effect.

B. C. Plants Operating at Full Capacity—Much Prospecting and Development Under Way

FOUR big companies operating in British Columbia—namely, the Consolidated Mining & Smelting Co. of Canada, the Granby Consolidated Mining, Smelting & Power Co., the Britannia Mining & Smelting Co., and the Premier Gold Mining Co.—are operating their respective plants at close to capacity and are turning out the customary quantities of metals.

The Kootenays continue to be the chief center of mining activity. The Lucky Jim Lead & Zinc Co., which was the largest independent shipper to the Trail smelter in 1926, has blocked out a large tonnage of ore above No. 5 adit, and is now preparing to prove the downward extension of the several oreshoots in No. 6 adit, 700 ft. on the dip of the vein below No. 5. No. 6 adit already has been driven for a considerable distance, but appears to be out of the ore zone, and, besides further drifting, a good deal of crosscutting will have to be done to prove the oreshoots at this depth. The annual general report of the company is in preparation, and it is expected that it will place before the shareholders some plan for financing the erection of a 150-ton mill at the mine, as, palpably, the shipping of ore to the custom concentrator at Trail is far from economical.

Whitewater Mines, Retallac, B. C., which is operating at 600 ft. greater depth than any other silver-lead-zinc mine in the Kootenays, will erect the first 100-ton unit of a mill in the spring. It is expected that the plant will be in operation by the end of June.

Slocan King Mines, operating on the eastern extension of the Silversmith-Slocan Star lode and at depth by extending the Silversmith No. 10 level east, reports that the level has been driven in milling ore for 200 ft. in Slocan King territory. The level is 800 ft. below the surface, with virgin ground between. It will be continued to open the Richmond-Eureka oreshoot, 800 ft. ahead of the present face. Ore from this mine will be crushed in the Silversmith mill.

Silversmith mines, Sandon, B. C., reports that development on No. 10 level has opened four new oreshoots and that operations are being carried on in four full faces of milling ore. All ore bins are full, and the company has concentrates to the value of $80,000 on hand. Unless metal prices show a further slump, shipping will be resumed in the near future.

The new deep tunnel at the Florence mine, Ainsworth, B. C., which is being driven to open the orebodies at 400 ft. below the old workings, is being pushed forward at the rate of about 10 ft. per day. Preparation is under way to extend No. 2 tunnel, to open a shoot mined in the upper workings on the Twins claim. The ore in this shoot was of a higher grade than any in the mine.

Negotiations between Porcupine Goldfields Development & Finance Co. and the Standard Silver-Lead Mining Co., Silverton, B. C., for a lease and option by the former company on the old Standard mine, at Silverton, which have been under way for some time, are reported to have been practically completed. For a quarter of a century the Standard was the banner mine in Slocan; it paid its owner $2,700,000 in dividends and left a reserve of some $400,000 in the treasury. It was worked only to a depth of about 800 ft. The Standard company turned the mine over to lessees during the "One Big Union" strike, which held up operations in the Slocan district in 1918-19, and though several groups of lessees have found a good deal of ore, the directors considered that for big-scale operations the mine was worked out. The mill, the first flotation mill in the district, was burned last year. Porcupine Goldfields evidently is prepared to take a chance on finding the downward extension of this profitable oreshoot, and, considering the deep development now under way at the Whitewater, Silversmith, and Ruth-Hope mines, it appears to be a worth-while gamble.

Developments on Vancouver Island

Vancouver Island is coming in for a good deal of attention. W. M. Archibald, manager of mines for the Consolidated M. & S. Co. of Canada, and several other officials of the company have been spending a good deal of time at the Old Sport mine, on Quatsino Sound, which Consolidated controls. Important developments are likely to ensue in the near future. The mine has been under steady development for several years, and a large reserve of copper ore has been blocked out. Britannia Mining & Smelting has made an exhaustive examination of the Gabbo group, on Jordan River, and is reported to be negotiating for a lease and bond on the adjoining Sunloch mine, where a large reserve of copper ore has been developed. Sunloch is controlled by the Consolidated M. & S. Co. of Canada, but it is readily conceivable that if arrangements were made for Consolidated to treat the output it would not object to another company's operating the mine.

Portland Canal District

In the Portland Canal district the long-promised starting of the Dunwell mill has become an accomplished fact. The mill is said to be operating satisfactorily. It is treating 50 tons per day, and the superintendent expects to have it soon running at its full capacity of 100 tons.

The Standard Silver-Lead Mining Co., Silverton, B. C., has put up a raise from the Taylor tunnel at the Red Top group, near Topley, on the Canadian National Railway, has erected a hoist, and is now sinking below the tunnel. The new shaft has passed through some high-grade gold-silver-lead-arsenic ore. This property is said to be standing up to the high opinion that has been formed of it. A camp and an assay office have been erected.

Five cars of machinery have arrived at Smithers for the mill at Duthie Mines' Henderson mine, on Hudson Bay Mountain, and the remainder of the plant is expected daily. Sledding between Smithers and the mine—13 miles—is excellent, and this is greatly facilitating the moving of the machinery. The mill will be operated on an all-flotation basis; and the first unit will have a capacity of 50 tons per day.

Inspiration Cuts Production

On account of the weakened condition of the copper market Inspiration Copper Co. has reduced its operating force 30 per cent. The leaching plant will be run at capacity, but the concentrator production will be cut down 50 per cent. In the underground department stoping will be reduced, but development will not be curtailed. The total working force to be maintained will approximate 2,500 men.

U.V.X. Expanding

United Verde Extension, Jerome, Ariz., has been active during the last year in investigating and acquiring options or actual ownership of what appear to be desirable properties. In addition to the options on some claims in the Rouyn district of Quebec and exploratory work now going forward at Bisbee, the company has acquired a lead-zinc mine in the Joplin field of Missouri and a property in Chile. It is understood that the latter has partly proved up ore reserves of 30,000,000 tons of disseminated ore. At the Jerome property production in January totaled 3,405,972 lb. of copper, compared with 3,173,480 lb. in December and 3,974,110 lb. in January, 1926.

New Shasta Gold Dredge

A small gold dredge owned by Ogden and Wilson was placed in operation on Feb. 24, 1927, on Roaring River, a branch of Cottonwood Creek in Shasta County, Calif. Lawrence Gardella is operating two gold dredges on Clear Creek in the same county. In Trinity County, the Lewiston Dredging Co. is operating a dredge upon the Trinity River, as is also the Trinity Dredging Co. and the Estabrook Gold Dredging Co. Thus six gold dredges are operating in Shasta and Trinity counties.

Grasfontein Diamond Rush

Twenty-five thousand diggers, clad in running togs or bathing suits, set off at noon on March 4 for the new Grasfontein (South Africa) diamond rush on the lowering of the Union Jack at the starting point three miles away from the claims. Owing to the distance many were unable to make speed over the rough veldt, with the result that fifty trained athletes, engaged for large sums by wealthy persons, justified their fees by pegging the richest claims. Incidentally some of these athletes lost their amateur status by accepting money for participating in the rush under the pay of syndicates.

There was an unparalleled scene as the vast mob, mostly wearing ferns and handkerchiefs to protect their heads from the sun, set off with a rush. The postponement from Feb. 25, caused by a false start, merely had the effect of

increasing the number of competitors. A hardened digger of seventy kept up with the professionals and declared that he had captured the best claim. Thirty thousand spectators witnessed the spectacle.

A half hour later motorists were permitted to follow the runners. Cars were driven pell-mell across the veldt despite ditches and ant hills. The Grasfontein fields are reputed to be among South Africa's richest. From six claims alone diamonds worth more than £50,000 were taken recently.

Immediately after the claims were pegged many of the more hopeful began digging feverishly. Early in the day several men were arrested who had been found in hiding places along the route to the farm in the hope of getting ahead of the runners, when the starting signal was given.

At the time the rush was on, an urgent application for an injunction was made at Pretoria in behalf of a group of diggers who challenged the legality of the subdivision of the Grasfontein farm.

Sidney Ships 175 Tons Daily

Shipments are being made by the Sidney Leasing Co. from the Sidney mine, on Pine Creek, at the rate of 175 tons daily, according to reports received at Spokane from Wallace. The ore is reported to be 6 to 8 ft. wide and 15 ft. wide on one level.

Abana Mines Litigation Ended

Litigation which has interfered with the operations of the Abana Mines, Ltd., of the Rouyn area of Quebec, has been dropped as a result of an adjourned annual meeting of shareholders held at Montreal. President J. C. Lamothe defended the course of the management, pointing out that of four actions that had been brought against the company's officers, only one had been successful. He intimated that he would not be a candidate for re-election and would place no obstacles in the way of the election of a new directorate. The following board was elected: Alfred Savard, president; Dr. Joseph P. Laporte, E. Gadbois, Hector Authier, and J. B. Rochester.

Harkness Hays Development Under Way

Active development is being pushed by the Harkness Hays Gold Mining Co. on two claims comprising 93 acres situated about two miles east of Schreiber, Ontario. A modern mining plant has been installed, no hoisting apparatus being necessary, as drifts are being run into the side of the hill, which rises to the height of 250 ft. Eight gold-bearing veins have been opened on the surface, some of which are 600 ft. long. Assays show a fair gold content. So far about 300 ft. of work has been done, with highly encouraging results. Operations are in charge of W. Dean Hays, president and general manager, formerly with the Anaconda Copper Mining Co. J. C. Houston, of Haileybury, has been retained as consulting engineer for the company.

Mines Awarded Certificates for Exceptional Safety Records

INSTANCES of the operation of mines over long periods of time with exceptional safety have been commemorated by the Holmes Safety Award Committee of the Joseph A. Holmes Safety Association in the awarding of certificates to two coal-mining operations whose records show the production of great tonnages of coal without a fatal accident, and to a metal mine and a stone quarry where no employee lost even as much as a day's time because of injuries.

In the metal-mining field, a certificate was awarded to the Muncie zinc and lead mine, operated by the Federal Mining & Smelting Co., Baxter Springs, Kan. This mine was operated from July 23, 1925, to Dec. 31, 1926, not only without a single fatal accident but without a "lost-time" accident underground. A "lost-time" accident is one in which the injured worker loses at least a full day's work as the result of the accident. A total of 39,489 underground man-shifts, equal to 315,912 man-hours, was worked during this time without a "lost-time" accident.

In the quarrying field, a certificate was awarded to the Speed limestone quarry, operated by the Louisville Cement Co., Speed, Ind. No fatal accidents and no "lost-time" accidents occurred at this quarry during a period of more than two years from June 1, 1924, up to Dec. 31, 1926. A total of 545,497 man-hours, or 60,611 man-days, was worked at this quarry during this period.

The Joseph A. Holmes Safety Association is an organization named in honor of the first director of the U. S. Bureau of Mines, now deceased. Its principal aim is to further the cause of safety among the million miners of the United States.

Geological Report on Western Canada Available

The summary report of the Geological Survey of Canada for 1925 has just been published. It represents the results of field work carried on in the western Cordillera of Canada during the summer of 1925, and contains descriptions of the argentiferous lead deposits of Galena Hill, Mayo district, Yukon, and Atlin, British Columbia; of the gold placers and bed-rock geology of Dease Lake area; of the Hat Creek coal deposit; and of the ore deposits of Slocan mining district. The report contains descriptions of known mineral deposits and is accompanied by geological maps. Copies may be had on application to the director, Geological Survey, Ottawa, Ontario, Canada.

Consolidated M. & S. Developing Quebec Property

The Consolidated Mining & Smelting Co. of Montreal, Canada, is preparing for development work on an extensive scale on several of the properties which it has acquired in the Rouyn mining area of Quebec. In Hebercourt Township, where the company holds a large acreage, camp buildings are being erected and surface work will be carried out in the spring, to be followed by diamond drilling. At the property on Flavrain Lake, in Duprat Township, a two-story building has been erected, to accommodate twenty-four men. The company has a large block of claims west of Flavrain Lake, where some discoveries of copper have been made. A survey of the ground is being made, and in Montbray Township there is under way a magnetic survey preliminary to surface work which will be started in the spring. Camps have already been erected.

Wright-Hargreaves Begins Mill Addition

At the Wright-Hargreaves, Kirkland Lake, Ontario, excavation for the addition to the mill has been started. When the mill, which, according to plans, will be of 250 tons' capacity, is completed, it will bring the total tonnage up to about 750 tons daily. It should be ready for operation by the middle of June. Pockets and skips which are being installed in preparation for the handling of the increased tonnage are expected to be in place in the main shaft on the south vein and in operation by the end of March.

Venetti-Todd Makes Final Shipment

The Venetti-Todd lease on the old Garfield mine, adjoining the Mabel mine of the West End Consolidated Mining Co., on the east, 20 miles westerly from Mina, Nev., has made its final ore shipment and ceased operations. This last lot represented carefully sorted ore over a long period of time, and the 34 tons assayed $234 per ton in silver, gold, and lead, giving net returns from the smelter of $207.71 per ton.

French Patents Declared Invalid

The action brought in the Exchequer Court of Canada by the Electrolytic Zinc Process Co. of Montana to invalidate the patent for the electrolytic process of zinc reduction owned by French's Complex Ore Reduction Co. of Canada, Ltd., resulted in a decision by Judge Audette cancelling the alleged French patent. Presumably this will terminate the previous action brought by the French company against the Electrolytic Zinc Process Co., which has been halted in the Quebec courts awaiting the decision in the Exchequer Court.

News from Washington

By PAUL WOOTON
Special Correspondent

Senate Filibuster Prevents Additional Appropriations for Bureau of Mines

The filibusters which characterized the final week of the session of Congress prevented Senator Oddie from carrying out his plan to attach his bill, providing for additional funds for the Bureau of Mines, as an amendment to the second deficiency bill. The failure of that measure also prevented the appropriation of funds for the continuance of the oil-shale plant of the Bureau in Colorado and for the work on manganiferous iron ores at the Minneapolis experiment station.

In response to a well-defined demand in the West, the Senators from the mining regions were prepared to lend all the support within their power to make the Oddie bill a part of the deficiency appropriation bill. The Oddie bill had been reported favorably by the Committee on Mines and Mining. General interest in the legislation was attested by the many letters received supporting the proposed appropriations. The demand from the metal-mining regions for studies of geophysical methods of prospecting was particularly strong. The unusual demand for printed copies of the hearings dealing with the proposed appropriations is regarded as further evidence that the mining industry is becoming more assertive and will be more insistent in the future that the federal government do its part in helping the industry with those problems which cannot be undertaken effectively by individual companies.

Western Senators are returning to their homes imbued with the idea that a drive must be made at the next session for a greater recognition of the mining industry.

The $1,063,000 for the securing of new supplies of helium and $7,500 for helium research was not caught in the legislative jam and is now available. The Bureau will now start on an intensive search of all gas fields with the idea of locating additional supplies of helium. The effort is primarily intended to locate supplies of this gas for the army and navy.

Co-operation Between Mining Bureaus of Canada and United States

At a meeting between representatives of the U. S. Bureau of Mines and the Mines Branch of the Canadian Department of the Interior, held in Ottawa, Ontario, on March 1, arrangements were made for the close co-operation of the Canadian and United States governments in carrying out investigations affecting the mineral industry in both countries. The chief purpose of the meeting was to come to a common understanding of the problems affecting the mineral industry and to devise ways and means by which information can be pooled and present and future investigations co-ordinated to the advantage of both countries.

The work of the United States Bureau was outlined by Dr. Dorsey A. Lyon, chief metallurgist and supervisor of experiment stations, and his assistant metallurgist, O. C. Ralston, and that of the Dominion Department by John McLeish, director of the Mines Branch, and members of his staff. The Research Council of Canada was represented by J. G. Morrow and F. E. Lathe.

Scientific methods of prospecting, such as have been used in the location of iron, copper-nickel, and recently the copper-zinc-gold orebodies of Western Quebec, were discussed. Canadian experts believe these methods will find a much wider application in the future.

At a subsequent meeting of the Ottawa branch of the Engineering Institute of Canada, Dr. Lyon made fitting allusion to a policy of co-operation initiated between Great Britain and the United States, through the exchange of experts, an experiment that was already bearing fruit. Dr. Lyon urged the advisability of co-operation in similar ways between Canada and the United States, which he considered would be of mutual advantage.

Whitedelf Making Regular Shipments

The Whitedelf Mining & Development Co., which recently opened a mine at Clark's Fork, Bonner County, Idaho, has since Aug. 1 shipped 32 carloads of ore, yielding over $62,000. These shipments have come from regular development work, only a little ore being taken from stopes. Plans are being prepared for the construction of a mill to handle the low-grade ore, which occurs in veins varying from 20 to 30 ft. wide.

Arcadian Resumes Development Work

Arcadian Consolidated, Houghton, Mich., has resumed development work in the New Baltic shaft after pumping out the water. Two drifts have been started, the 9th level to the north and the 12th or bottom level to the south. The 9th is opening ground well charged with copper, and the 12th is just getting under way. Discovery of good copper rock to the north is particularly encouraging, as it tends to prove the vein on both sides of the shaft. The 9th level south has already opened long stretches of commercial rock.

Western Clay Companies Consolidate

Purchase of the Denny Renton Clay & Coal Co.'s plants in Washington, Oregon, Montana, and British Columbia has been announced by Gladding, McBean & Co., manufacturers of terracotta and clay products in California. The Gladding, McBean company operates six plants in California, and as a result of the new consolidation will have 200 kilns and will employ 2,000 men. The company mines its own clays from deposits in California.

Powder Gas Overcomes Men at Junction Mine

A. Ramson was killed and seven other miners were overcome by gas in the Junction mine at Bisbee, Ariz., recently. The men had fired a large amount of powder in a stope on the 1,600 level and had returned to their working places before the gas cleared away. All eight were found unconscious about half an hour later by other employees working on the level. Seven of the men were revived, and they will, it is said, suffer no lasting effects from the gas, but Ramson could not be brought back to consciousness, although artificial respiration was given him for over an hour.

Kay Copper Reported to Have Found New Ore

An announcement of a discovery of a body of lead-zinc-silver-gold ore at the lowest level of the Kay Copper Co.'s mines at Canyon, Ariz., has recently been made by President Godfrey. Assays are said to have run as high as $5.17 gold, 18 oz. silver, 9.10 per cent lead, and 9 per cent zinc. The ore is said to be readily amenable to the flotation process of extraction.

The new orebody is said to be 21 ft. wide and to have been proved up for a length of 100 ft., but its full length has not yet been determined. This orebody is said to be entirely distinct from the two major copper orebodies which were also traced to the lowest, or 1,500 level.

Announcement is also made that upon recommendation of the reorganization committee, and subsequent ratification by a majority of stock, an escrow agreement, covering 1,919,000 shares of Kay Copper Corporation stock, held for distribution among stockholders of the Kay Copper Co., the predecessor company, has been extended until Jan. 23, 1929.

Officials of the New York Curb market recently removed several mining stocks from the trading list. Among those which were dropped after being investigated was Kay Copper, which recently dropped from $1.25 to 25c. a share.

Silver Age Making Regular Shipments

Seven feet of bedded ore assaying 13 oz. of silver to the ton and 57 per cent lead has been broken into in the stope below the main tunnel level of the Silver Age Mining Co., Lane City, near Ely, Nev. Regular shipments are being made. The company plans to erect a mill in the spring to handle the milling ore being exposed in mining high-grade.

Gold Production in Canada Increasing

In a recent pamphlet entitled "Gold in Canada" the Mines Branch of the Dominion Government ventures the opinion that future gold discoveries in Canada will surpass any now known. Reference is made to the immense areas of unprospected territory underlain by

ancient crystalline rocks similar in character to the present highly productive area of northern Ontario. The gold production of Canada between 1858 and 1926 is given as 29,819,019 oz., valued at $616,413,528. Though world production has shown a tendency to decline since 1912, Canada's gold production is steadily increasing, and in 1926 reached 1,729,000 oz., valued at $35,749,000. The mines of Porcupine and Kirkland Lake, in northern Ontario, produced 85 per cent of this amount, and British Columbia accounted for 14 per cent.

The discoveries made in the Porcupine district during the period 1905 to 1920 are seen by the Mines Branch to "have disclosed the most important new gold production area found anywhere in the world during the last quarter century," and the recent development work in the Rouyn district of northwestern Quebec "has disclosed important bodies of auriferous copper ores, and prospects are bright for a greatly increased production."

M.C.M. Becomes Michigan Tech

The Michigan Legislature has passed a bill changing the name of the Michigan College of Mines at Houghton to the Michigan College of Mining and Technology. The name will be popularly shortened to "Michigan Tech." One of the first steps under this bill will be to act on the authority given to enlarge the curriculum to include engineering subjects other than those restricted to mining engineering.

The bill making the change above noted provides for the granting of a scholarship to each state in the Union, each province of Canada, each possession of the United States, and each of the Latin-American countries. This, it is expected, will result in the accession of a considerable number of high-grade students who will help to maintain the high standards of the college and prove of distinct value as a broadening influence. In addition to these scholarships, one scholarship is offered each year to each of the high schools of Michigan.

Lost Park Organized

The Lost Park Mining Co., Divide, Colo., has been organized recently with C. M. Tucker and Melvin Croniwett as the organizers. The company has acquired property around Divide and has already started development work, with fifteen men employed. Propably the most valuable find has been a vein of molybdenum ore near the Red Skin claim, adjacent to the Prince and Tucker claims.

Nova Scotia Lead Optioned

The lead-ore deposits which occur about sixteen miles from Truro, Nova Scotia, in Colchester County, are to be the object of extensive exploration work this year. The British Metal Corporation, Truro, N. S., has taken a working option on thirty-seven square miles of ground in which these deposits occur. The company is installing machinery preparatory to sinking on the orebody to a depth of possibly 500 ft.

Toronto Letter

By Our Special Correspondent for Northern Ontario

Narrow Lake Development Under Way

Flin Flon Test Plant Started—Auction Sale of Noranda Town Lots

Two diamond drills are being taken into the Jackson-Manion property, which is at Narrow Lake, to the northwest of the Red Lake district. This property is under option to N. A. Timmins, Incorporated, which company plans to do a considerable amount of development and exploration work. The vein is comparatively narrow, but surface exposures have been found here and there over a length of several thousand feet, and as a general rule these give satisfactory assays. A new road from Pine Ridge to Narrow Lake has been completed, and all supplies necessary for operations will soon be on the ground. The Red Lake Transport Co. has opened up a new winter transportation base at a point 24 miles west of Hudson. Camp buildings have been erected sufficient to accommodate 60 men and there are 31 teams freighting supplies in for the different interests. This point is 5 miles from Pine Ridge, which is considerably shorter than from Hudson, the original starting point.

The Bathurst Mines, which was recently organized to take over a number of properties at Narrow Lake, is making arrangements to develop its claims. An assay plant, together with supplies sufficient to last until next summer, is being sent in. For the present surface work only will be done, but it is hoped by the end of the summer to have sufficient information to justify the company in sinking a shaft. Several veins have been found on these properties, and encouraging assays have been obtained.

At the Flin Flon property, in northern Manitoba, the new mill has started operations, and it is expected that the organization will be in a position to start shipping concentrates by about next May. The present plant is considered as only a test plant, but to bring it to this stage has meant a total expenditure by the Whitney interests of approximately $750,000. If the property is developed in a large way, it will require the expenditure of several million dollars, as diamond drilling has indicated a total of 20,000,000 tons of commercial ore.

At the recent annual meeting of the Wright-Hargreaves Mines, Kirkland Lake, it was decided to increase the mill capacity to 700 tons a day. A new hoist capable of carrying operations to a depth of 3,500 ft. is being shipped from England, and a compressor which will double the air capacity should be installed and operating by the end of March. By the middle of summer the mill additions should be completed.

Paymaster Mines, of Porcupine, has purchased a large amount of concentrating machinery in Nevada, which will be shipped to the Porcupine property for the 1,000-ton concentrator which the company plans to erect. A start has already been made on the construction of this mill addition. The present mill, which is a cyanide plant, has a capacity of 350 tons a day. At present the tonnage is less than this, on account of the large amount of development work under way. When the new shaft is completed the mill should be working at capacity, and officials believe that at 350 tons a day, even on $2.75 ore, they can make operating expenses. A new five-compartment shaft is being put down to the 300 level, and when it is completed to that point, which should be about the end of May, there will be no difficulty in obtaining ample supplies of ore.

Officials of the Noranda Mines, Ltd., announce that a public auction will be held in Rouyn April 6 and 7, at which lots in the townsite of the Horne Copper Corporation will be sold. The Horne Copper Corporation, which owns all the land, has expended approximately $100,000 in improving the townsite. Three and a half miles of road have been put in and sewers and water mains laid.

Cobalt Activities

The Cobalt Contact Mines, Ltd., which operates in Cobalt, has acquired the old Ruby property, adjoining on the west; 300 ft. of sinking and 2,800 ft. of drifting and crosscutting have been done on the property, and considerable silver has been proven.

The Harvie Mining & Exploration Co. has taken a lease on the Silver Leaf and Imperial Crown properties in Cobalt. No ore has been mined from the Imperial Crown, but a number of years ago the Silver Leaf produced 200,000 oz. from the extension of the Carson vein of the Crown Reserve.

Forecasts of the Nipissing report for 1926, which will be issued in about six weeks, indicate a drop in production, profits, and cash. Production is estimated at about 2,000,000 oz. of silver, having a value of $1,160,000, against $1,582,000 in 1925. Though production in ounces is only slightly less than the record for the previous year, the drop in the price of silver accounts for the big difference in value. Net profits from operations are estimated at $400,000 and other income was $200,000; a total of $600,000, against dividend requirements last year of $720,000. Cash as of Dec. 31 was approximately $3,700,000, compared with $4,300,000 for the corresponding date of 1925. This decrease in cash is accounted for by the expenditures on properties and options. The company has a very promising property in Montbray, which is considered an asset of substantial value. Ore indications to date show comparatively small lenses, but they run exceptionally high in gold.

Asbestos Corporation Increases Operating Profits

Encouraging facts are contained in the annual financial statement of the Asbestos Corporation of Canada. Operating profits for the eleven months ended Dec. 31, 1926, amounted to $1,237,008, compared with $781,979

shown by the old company for the entire 1925 period. Income from investments amounted to $86,649, bond interest required $426,983, and deduction for depreciation to the amount of $300,000 was made, this comparing with $150,000 by the old company in 1925. Preferred dividends required $391,445, leaving a balance of $205,228 applicable to the common stock. Current assets are shown at $3,295,866, against $4,150,533 by the old company at the end of 1925, and current liabilities are only $417,426, compared with $1,029,496, which was the last showing of the old company. This leaves net working capital at the comfortable figure of $2,878,440.

Nova Scotia Encouraging Gold Mining

The Nova Scotia Legislature has given second reading to a bill which includes several provisions designed to encourage gold production in that province. These include exemption of gold production from payment of the regular 35c. per ounce royalty for the next five years, reduction of the fees for prospecting areas, increase in the size of lease holdings from six to twenty acres, compulsory development of holdings, and abolition of the regulation demanding that applicants for areas must furnish within thirty days a bond to cover possible damage claims made by holders of surface rights.

Laurier Mines Developing Rouyn Property

According to information emanating from the mining fields of northwestern Quebec, preparations are now under way with a view to prospecting thoroughly the large group of claims which Laurier Mines, Ltd., has secured in the Rouyn district. Laurier Mines, Ltd., is a consolidation of 47 groups of claims, a total of over 20,000 acres, which will give this company larger holdings than are possessed by any other corporation operating in Quebec. A good deal of this property was staked or optioned before the real rush to Rouyn got started. The claims lie in eight different townships, and a number of them are in the immediate vicinity of or adjoin properties now under development. Supplies are to be taken in at once to the claims adjoining the Granada mine, in Rouyn Township. Camps are to be started immediately.

Alta Tunnel Strikes High-Grade Ore

Fourteen hundred feet vertically below the surface and 300 ft. below the lowest level of the old Prince of Wales mine, Alta, Utah, the Alta Tunnel & Transportation Co. has opened up four feet of bedded ore assaying 50 per cent lead and 50 oz. of silver to the ton. After taking out 100 tons of ore and finding no lateral nor no northern limits to the ore, mining was interrupted by a snowslide, which killed one miner and slightly injured several others. Damage from the slide has been repaired, and stoping operations are again under way.

Mexico City Letter

By W. L. Vail

Special Correspondent

Silver Coinage Restricted—New Taxes in Zacatecas—Chontalpan Closes Prosperous year

Mexico City, March 2 — President Calles has signed a decree which orders that the mint will not coin, or recoin, as from date, more silver currency either in pesos or 50c. pieces. This is the first step taken by the Finance Department in an effort to stem the steady depreciation of the silver currency of the country. Strict measures have already been taken to prevent gold from leaving the country, and the present stock of gold will be augmented by increased coinage. All the banking institutions of the country are working in harmony with the government's program to prevent a financial crisis.

The annual report of the Chontalpan Mining Co., Guerrero, shows a profit of 271,938 pesos and the outlook for a prosperous new year. Capital stock was increased by $100,000 during the year, all immediately subscribed by present holders of stock. Two dividends were paid during the last year, of 1.25 pesos each per share, and more than half a million pesos has been carried over to assist in the payment of recently acquired properties and improvements. The company recently closed the purchase of the Xitinga mines, in the same district, for $300,000, on favorable conditions of payment. An automobile roadway is now being completed between the Chontalpan camp and the Xitinga properties, where a new plant will be erected. H. W. Fowler, general manager of the company, is now in the United States arranging for the purchase and installation of a new plant at Xitinga. It is hoped to have equipment installed and in operation by the close of the present year.

The Chontalpan people have also taken over, under working option, the properties of the Guerrero Exploration Co. and the Maria del Monte claims (adjacent), 183 claims in all. These will be worked in connection with the Xitinga unit.

Peñoles Company Active in Taviche

The Peñoles company has taken over the Conejo Colorado mine, in the Taviche district of Oaxaca, and its engineers are now on the ground laying out a plan for extensive development of the property. This is the first entrance of the Peñoles company into the Taviche district, where the American Smelting & Refining Co. is heavily interested, although it has been successfully operating for the last two years in the Sierra Juarez. Several other properties in the same district have recently been let under option.

Lagunera Mining Co., in Coahuila, has applied for permission to exploit a number of claims recently taken up in that state and the adjoining state of Durango, and expects to put a large number of men at work. The Mercury Mining Co., Zacatecas, has recently acquired title to six turquoise claims near Villa Gonzales Ortega, Zacatecas, and expects to begin exploitation soon.

The Mexican Lead Co., Monterey, N. L., has closed down work at San Pedro and San Pablo, letting out about 200 laborers. Work has stopped on the Cabrera mines, Pachuca, the property of the Real del Monte company, because of the continued low price of silver and low grade of the ores.

Zacatecas Taxes

The state government of Zacatecas has recently issued a new decree placing a special tax on mining operations in that state. Under the governor's ruling, gold and silver will pay a special tax of 2 per cent on values extracted. Copper, zinc, lead, antimony, mercury, and other minerals, will pay a tax based on the monthly quotations. Mining companies will be obliged to make a deposit with the state treasury of a sum, to be set by the state authorities, sufficient, in their estimation, to guarantee prompt payment of taxes and fines, when assessed. Smelters and plants of all sorts will be required to pay a 5 per cent tax on their valuations. Failure to liquidate within eight days calls for heavy fines and seizure of plants in the event of their not being promptly paid.

Stratton Mines Developing Panhandle Mine

Having paid for its purchase in operations from grass roots, the property of the Stratton Mines Co., Wallace, Idaho, operating on Nine Mile, in the Coeur d'Alene region of Idaho, has almost paid for a neighboring property, the Panhandle, according to reports received at Spokane from Wallace. Until recently the Stratton had shipped five carloads of smelting ore. A drift is reported to have followed ore for about 100 ft. beyond the fault on the 200 level. Forty men are employed.

Ore of a milling grade is undergoing development on two levels of the Panhandle mine, adjoining, but on the opposite side of the Nine Mile Gulch. A spur from the Northern Pacific railroad is being constructed. Completion of this spur will facilitate the delivery of a pump and the movement of ore.

Leaching Ore in Place on a Commercial Scale

The Nevada Bellevue Copper Co., Contact, Nev., is leaching oxidized copper ores in place on a commercial scale. The mine is opened by a tunnel, which cuts the orebody at a depth of 250 ft. below surface. A solution of 3 per cent sulphuric acid is introduced at the outcrop and percolates through the ore to the tunnel level, where it is caught by dam and conveyed through wooden pipe into vats, and the copper precipitated on scrap iron. Reports indicate that about 60 per cent of the contained copper is recoverable by this method, and that between eight and nine million pounds of copper may be recovered from the estimated 400,000 tons of ore available for this treatment. The work is being carried on under the direction of W. E. Dunkle, general manager.

London Letter

By W. A. Doman
Special Correspondent

Big Profits for Consolidated Mines Selection—East Geduld Shares on Market

London, Feb. 22—One of the most successful of the London mining finance houses is the Consolidated Mines Selection. The profits earned in the last calendar year constitute a record, for they are close upon £300,000, as against £80,000 in 1925 and £74,700 in 1924. The dividend is raised to 30 per cent from 15 per cent; over £52,000 is placed to reserve, and £70,000 goes to form a dividend equalization reserve fund; and about £28,500 is carried forward, in contrast with £10,185. Shareholders and the market are eager to learn how such results have been obtained, especially as it is whispered that the present showing is not the whole of the picture. Assets have been written down considerably, and there is a large hidden reserve. The company holds a substantial interest in the allied Anglo-American Corporation of South Africa, and it would appear that the dividend of 30 per cent could be paid without trenching upon the 12½ per cent received on the Anglo-American shares. Both companies are interested in the Mount Isa mine, Queensland, and of this great things are expected. Capital developments are reported officially, and it is said unofficially that even better results are to be announced. Whether either company has any firm shares in the Mount Isa is uncertain, but options are held over something like 500,000.

East Geduld shares were first dealt in last week at about 1¼. It was intended to introduce them at 1¼, but dealings started in Johannesburg up to 33s. and created such a demand here that 25s. was not practicable. It is stated that driving is proceeding in the area from five of the Geduld Proprietary levels, and that the disclosures are satisfactory.

Kaffirs have in reality been the most prominent of mining shares during the last week, and New Modderfontein, the great mine of the Rand, has reached 5¾. Apart from talk of cleaner stoping, it is said that developments of extraordinary richness are taking place in a new upper leader.

The newest property to attain prominence is the Rand Collieries, in the neighborhood of the Cinderella portion of the East Rand Proprietary. I have not heard that there are any developments, as no work is apparently being done, but there are suggestions that a market deal has been arranged, and there is talk of acquiring additional ground.

Mining circles are beginning to inquire when the promise of Bwana M'Kubwa is to be fulfilled. It is suggested that, as so many months have passed, the plant cannot be giving the satisfaction that was expected. Next year it is said production should reach an important figure, so that apparently there is still a long wait. This seems to be confirmed by the statement that the Anglo-American Corporation engineers have taken over the working of the treatment plant, and it is believed that the expenditure of a few thousand pounds will overcome the mechanical difficulties that have caused the delay.

Stanley Low, mining engineer, is soon to pay a visit to Panama to make a special report on the Panama Corporation properties. Duncan E. Alves, the promoter of the corporation, is also going there.

Mining in Luzon

By C. M. Eye
San Francisco, Calif.

The Suyoc district, in northern Luzon, is now exhibiting little activity. Many of the Americans who went in there soon after the occupation, and who remained, have died, and the few remaining are now old men, mostly with Igorote families, and worrying not at all. The mineralized area is large, being about 2 km. in width by 7 km. in length, with the gold occurring in small but often high-grade veins, and usually with the values in tellurides. This does not make for large-scale operations, and there is little to encourage outside capital to invest. An Englishman named Starky is working the Early Bird, toward the southern end of the district, and has erected a small milling plant on the Abra River for treating the ore. This plant I understood consists of a small ball mill and some sort of concentrating equipment. George Icard mined high-grade ore from the Early Bird in the early days. The ore assayed high, the values being in telluride minerals, but the vein was narrow and the distribution of values erratic. The difficulty in mining such ore is to prevent the natives high-grading the greater part of the rich portions, as they know the good ore better than anyone else, and have every chance to get away with it. It seems to me that this district is likely to go back to native mining. The great Palidin Slide, which has been sluiced from time immemorial, is a monument to the natives' industry and perseverance. One American outfit spent much money, bringing in a flume line to work this slide, only to find that it was too low in grade to pay. The only other activity in the district, not native, is that of certain Manila people who are driving on a lead which runs under the Slide.

Incidentally, I visited the famous old Mancayan copper mine, on the way from Suyoc to Cervantes, and spent a few hours in the old workings and in looking over the property. It is very interesting as an example of what can be done, even by primitive methods, with plenty of very cheap labor and a genius in charge, but as a potential copper producer I am afraid that it will have to await the day when copper is worth much more than at present and when local conditions are much more favorable. Lack of transportation is the greatest drawback. Considerable money has been spent in opening up the deposit on levels below the old Spanish workings, but I understand that the results have been discouraging and that the property is now in the hands of banks at Manila.

Johannesburg Letter

By John Watson
Special Correspondent

South African Mineral Production Gains £4,000,000 in Year—Ferreira Deep Near End

Johannesburg, Feb. 1—The Department of Mines issued statistics on Jan. 27 which show that the mineral production for the Union, for the last two years, has been as follows:

	1926	1925
Gold	£42,285,152	£40,767,982
Silver	126,299	166,842
Osmiridium	91,330	170,995
Platinum	93,307	.....
Diamonds	10,692,135	8,198,368
Coal	4,061,534	3,880,442
Copper	479,835	495,797
Tin	315,333	298,973
Other minerals	335,603	272,577
Totals	£58,480,528	£54,251,976

The annual meeting of the Ferreira Deep, Ltd., was held in Johannesburg on Jan. 28, when Frank Raleigh, the chairman, announced that for the year ended Sept. 30 the company's operations resulted in a net profit of nearly £58,000. In view of the approaching end of the life of the mine, it has been represented to the board that no further dividend should be paid until the company has first gone into liquidation, which will probably take place about the end of 1927 or early in 1928.

A movement is now being organized to hold the next meeting of the International Geological Congress in South Africa during 1929. This congress met for the first time in Paris in 1878. Since that date it has held meetings, every three or four years, in the capitals of many countries—at Vienna, Brussels, London, Berlin, Stockholm, and Washington. The objects of the congress are, essentially, of two kinds, to take stock of the progress of geological science through the reading and discussion of papers and to study, during carefully selected excursions, the conspicuous features in the general and economic geology of the regions visited.

South Africa is a country full of geological problems, especially of an economic nature, the correct solution of which may open up fresh avenues for exploiting its mineral wealth.

Louis Esselen, of Pretoria, recently visited the Lichtenburg diamond diggings. Interviewed by *The Star* correspondent, he advised diggers with little or no capital to keep away from these diggings, which are passing into the hands of men of means, who employ a good deal of machinery. Unless a man can carry on operations on a large scale he has little chance of success. For one claim (15 yards square) at Grasfontein, two brothers paid £1,000; out of it, already, £11,000 worth of diamonds have been extracted. As much as £700 worth of diamonds were got from this patch one morning before breakfast. As an offset to this, elsewhere, there are many failures.

On the Johannesburg Stock Exchange during the last week business has been active but irregular. The turnover has been large.

Situation at the Mines

Curtailment in Copper and Zinc Production General—Development Work Increased in Proportion

By Albert H. Fay
Assistant Editor

THE LAST YEAR was good for the mining industry; in fact, better than the average. Copper production was about 4 per cent above that of the previous year, and the lead increase amounted to 5 or 6 per cent. Iron production, of course, was larger than in previous years. However, the recent decline in the price of silver, copper, lead, and zinc has resulted in a small curtailment of production in many of the districts. This decrease in production, however, has been more or less offset by more extensive development work, so that as a rule it has not affected the labor situation. No labor shortages or labor troubles are reported from any of the mining districts, nor is there any appreciable surplus of labor.

Average Prices September, 1926, to February, 1927

	In Cents			
	Copper	Lead	Zinc	Silver
Average, 1925	14.042	9.020	7.622	69.065
September	14.062	8.786	7.413	60.580
October	13.862	8.402	7.296	54.505
November	13.576	8.005	7.199	54.141
December	13.302	7.855	7.018	53.466
Average, 1926	13.795	8.417	7.337	62.107
January	12.990	7.577	6.61	55.795
February	.....	.....	.....	.....

Copper.—In the Michigan district, the Seneca mine is increasing its production, and the Calumet & Hecla is continuing an extensive development program. Copper Range is producing in excess of 2,000,000 lb. per month. Quincy plans to open a third shaft. The business at the smelters in the Michigan district has picked up again, following a temporary slump. Good-sized shipments are now being made, both to the east and midwest points. In Arizona the Shattuck-Denn, the C. & A., Phelps Dodge and United Verde Extension are sinking additional shafts and planning considerable development work. A number of the mines have curtailed production and are now diverting their efforts to development. In Lower California, El Boleo Mining Co. has been refinanced in Paris and plans an extensive development with the idea of shipping all its production to Europe. In Mexico a number of the copper producers have curtailed production to a limited extent. In the Butte district, on account of the market for copper, the Anaconda company has suspended operations at the Mountain View and Stewart mines. This will cut ore production about 10 per cent, leaving the total mine output about 16,000 tons per day. This amount will supply all of the requirements for the plants at Anaconda and Great Falls. Utah Copper and Nevada Consolidated have made a slight reduction in tonnage. In Queensland, Australia, the Mount Morgan Co., a gold-copper producer, is planning to conduct operations with steam shovels, and United States engineers are making a study of the situation for the management preliminary to making any radical changes.

In Ontario splendid progress is being made in the construction of the Noranda smelter at Rouyn. The first shipment (35 tons) of copper-gold ore from Rouyn was made on Feb. 23, to the American Metal Co., Carteret, N. J., by the Jay Copper-Gold Mines, of Arnos, Quebec. At Kamiskotia Lake, Ontario, about 1,300 copper claims, embracing 50,000 acres, have been staked, a large portion of which is by established Canadian mining companies.

Lead and Zinc.—Joplin production has declined about 25 per cent during recent months, the average weekly output being about 13,000 tons, compared with 17,000 tons last year. Stocks have mounted to approximately 34,000 tons, which is considerably above normal. The recent slight advance of $1 per ton for lead and zinc concentrate has revived the spirits of the zinc-mine operators. However, about one-fourth of the mills in the Tri-State fields are shut down. A number of the old dumps are being worked over, twenty-five to thirty plants being in operation. Construction of new mills continues to replace old ones which have become worn out or not of sufficient capacity to handle the mine production.

In the Sudbury district, Ontario, a high-grade zinc deposit is now under development by the Treadwell-Yukon company. Discovery of this orebody has attracted wide attention, and there is considerable activity in developing or prospecting at and near this property.

The electrolytic zinc plant in the Coeur d'Alenes is well under way and will furnish an outlet for many small mines producing zinc mainly or as an important byproduct. Production from the Star mine (Sullivan Mining Co.) is now 500 tons per day.

Lead-Silver.—Perhaps the most important recent interesting developments are the opening of promising orebodies in the North Lily mines and also in the Eureka Lily mine, both in the East Tintic district, Utah. These discoveries have induced adjoining property owners to plan extensive development campaigns in the hope of finding a continuation of this ore under their properties. Shipments from the Tintic district are from 125 to 160 cars per week. Park City shipments amount to about 8,700 tons per week. Bingham is shipping about 110 to 120 carloads per week. The Iron King mine, in Utah, reports the discovery of high-grade ore on the 1,200 level and has suspended shipments of 7 to 8 cars of iron ore per week to the Columbia Steel plant. In Utah the mine tax bill which was before the legislature, to assess mining property at five times the annual production instead of three times as at present, failed to pass.

Gold.—Little new is to be reported on the situation of the gold-mining industry. At Lordsburg, N. M., at the Eighty-Five mine, operated by Calumet & Arizona, a high-grade gold ore has been found. Prospecting and development continue unabated in Ontario, and milling capacity is on the increase. The most active drilling is probably at Area and Amulet, as a check-up on the electrical surveys. Amulet is making a shipment of ore for metallurgical tests. A recent report states that Hollinger's ore reserves are about $65,000,000, compared with $59,000,000 one year ago, and that working capital has been increased $6,000,000. In Alaska many smaller properties are active, and the dredging development at Fairbanks is making good progress. In Colorado a new 2,500-ton mill is being planned for operation in the Breckenridge district. Gold production at Tonopah is holding its own, and the Black Hills district continues the even tenor of its way, with one large producer and two or three small ones.

Iron.—The underground operations of the Minnesota-Michigan iron districts continue at a normal rate, and considerable stripping has been conducted during the winter. The Oliver company has recently added four electric 4-yd. shovels to its equipment. Pickands, Mather has installed equipment to open up a new mine at Bovey, Minn., in the Coleraine district.

Miscellaneous.—In South Africa the last "diamond rush" to be conducted by the Union Government was set for Feb. 25, but later postponed to March 4, when 25,000 diggers set out for the new Grasfontein field. It is said that in the future some other method of staking claims will be devised.

Considerable interest has been shown in the development of mercury deposits in Mexico, Washington, and Idaho. Tungsten ore, in commercial quantities, is reported at the Red Top property, in Stevens County, Wash.

Litigation.—During recent weeks considerable mining litigation has been under way, and among the actions involved may be mentioned the permanent injunction issued against George Graham Rice in the sale of Columbia Emerald stock. Sale of Julian Merger stock has been declared illegal in California. Anaconda has won the $6,000,000 apex suit filed against it by the Clark interests, and also its suit relative to the Carson patents. Trial of the Carson suit against United Verde Extension at Prescott, Ariz., will take place on March 15.

Societies, Addresses, and Reports

Proposed Plan of Rehabilitation of Hydraulic Mining

Root and Kingsbury Submit Recommendations to California Legislature—Cost of Construction to Be Paid by State and Federal Government, and Returned by Yardage Charge

THE Hydraulic Mining Commission of California, consisting of Lloyd L. Root, State Mineralogist, and W. S. Kingsbury, Surveyor General, completed its investigation and submitted its recommendations, based principally upon the investigations of Arthur Jarman, mining engineer, to the California Legislature late in February. The more important features are as follows:

"Hydraulic mining is regulated and controlled by the California Débris Commission under federal statute. That commission offered its collaboration and assistance in the investigation, and has made surveys, capacity estimates, and preliminary estimates of costs. Complete and cordial co-operation was maintained throughout the progress of the work; and our thanks are hereby tendered to Major C. S. Ridley, Secretary, and the other members of the California Débris Commission.

"The investigation shows that hydraulic mining may be resumed, not only without fear of damage to farming and other interests but with positive benefit to them, provided that impounding dams be constructed at strategic points, as shown on the map of the area under consideration. Preliminary estimates show that the erection of three dams and the purchase of storage in a fourth dam at a total cost of $2,405,000 would enable this industry to be resumed on the Bear, American, and Yuba Rivers.

"Mr. Jarman reports that the available water will only suffice for one-fourth of the activity of the early 80's and that the shortage of water will mainly restrict work on gravels above the average in gold content. His forecast is an annual output of gold only one-seventh that formerly obtained from the district described. Approximately 10,000,000 cu.yd., estimated to yield $1,156,000, would be mined annually, compared with 38,610,000 cu.yd in 1880, estimated to have yielded $8,000,000.

"To restrain the gravel from mines in this district, suitable sites for dams have been selected and surveyed, and at each of these the rock conditions must be tested by drilling. Some detail surveys are also needed to supplement and check the data already obtained. This work is required on Lower Bear River site, two sites on the Middle Fork of American River, two sites on the North Fork of the American River, and at the Narrows site on the Main Yuba. Six sites in all and possibly a seventh to enable a wise choice to be made for four dams.

"This work is estimated to cost from $50,000 to $60,000, and until this preliminary engineering work has been carried out, it is not possible to decide the exact position for the construction of any dam or ascertain its cost closely enough to call for bids for its construction.

"Assemblyman H. C. Cloudman was responsible for the bill that created this commission of investigation, and he has already introduced Assembly Bill No. 681, the object of which is to provide for the foregoing work to be done.

"Your commission recommends that the preliminary engineering to be done under this bill be done by the engineers of the California Débris Commission, as the commission must certify to the utility and practicability of the storage sites, as provided in Section 5 of the California Débris Commission Act.

"The plans prepared for the construction of dams will be co-ordinated with those for the development and conservation of the water resources of the state, as outlined in Bulletin No. 12 of the Department of Public Works, recently issued. The dam at the Narrows will be so constructed that it may subsequently be raised to the maximum practicable height as forecast in that bulletin.

"Upon receipt of favorable reports upon these dam sites and of estimates of débris that may be allowed to be mined behind dams built thereon, and upon receipt of estimates of the costs of such dams, this commission recommends that the balance of the moneys remaining unexpended under the appropriation named in this bill be utilized for the purchase of lands required as dam sites and as areas to be flooded.

"When estimates of the costs of dam construction on the Bear River and the North Fork and Middle Fork of the American River have been received, further legislation will be required to provide money for their construction and vesting the débris storage in the California Débris Commission. Preliminary estimates indicate that $905,000 will suffice for these dams, including the $300,000 expenditure upon the dam sites.

"When the site at the Narrows on the Main Yuba has been drilled and plans for the proposed dam confirmed as suitable by the California Débris Commission, and the allowable yardage of débris calculated therefor, legislation will be needed to provide a sum of $1,500,000 to purchase the total débris storage that can be obtained there by the erection of a dam to a crest elevation of 520 ft. This dam will provide a large amount of storage at a low price, which will enable the large low-grade gravels of the Yuba to be worked. No other dam sites examined showed costs that would enable these gravels to be worked, as revenue from power developable was too small in each case.

"The total expense anticipated is therefore $2,405,000 and should be provided one-half by the state and one-half by the Federal Government, as was done for the protection work on the Yuba above Marysville.

"Your commission recommends Mr. Jarman's suggestions that legislation be introduced in Congress to enable the California Débris Commission to purchase débris storage in a dam in lieu of actually building a dam. Also to amend the manner of charging a mine for restraining its débris in such a dam, or in a dam built by the commission, by making a charge per cubic yard of débris discharged from the mine in such manner that it will be restrained in whole or in part by the dam, credit being given for boulders and material permanently stacked at the mine.

"Also to provide that the charge per cubic yard shall be calculated so that the capital cost of the dam shall be returned by the mining of the yardage of débris estimated by the California Débris Commission as restrainable by the dam. The total cost of the dam would be divided by the allowable yardage of débris in order to ascertain the charge to be made per cubic yard. The existing provision of a charge of 3 per centum of the gross proceeds of a mine is much too small, producing only one-third of the cost in most cases.

"The sections of the Caminetti Act which provide for the protection of river channels and lands adjacent thereto should remain unaltered, and the above are the only recommendations made that affect this act.

"Benefits to be obtained from the adoption of the above program:

"1. Revival of Nevada and Placer counties, due to useful and productive work, requiring the employment of a considerable number of men in mining and other work dependent upon it.

"2. Benefit to Marysville, Sacramento, and San Francisco, due to orders for piping and mining machinery, machinery, materials and supplies, timber and general merchandise.

"3. Development of additional water supplies for mining that will be stored in the higher regions and released as used for mining. This will assist all plans for water conservation at lower elevations and tend to reduce salinity in the lower reaches of the Sacramento River.

"4. The effects of the above will be felt as soon as the construction of dams is started. The miners will prepare for work by driving tunnels and repairing sluices and refitting their mines as soon as it is assured that débris will be stored at a reasonable price so that hydraulic work may be resumed with due protection to farm lands below.

"5. Natural débris will likewise be prevented from being carried downstream, and this will benefit the navi-

gable channels by reducing the amount of dredging required. Dredging on the Sacramento River costs 6c. per cubic yard, and the cost of restraining débris by a dam is less than one-third of this.

"6. The Narrows Dam near Smartsville will render available considerable power and also water. The latter will be at an elevation of 520 ft., enabling it to be distributed over a large area of land with great benefit to the district below."

A condensed summary of Arthur Jarman's conclusions, as embodied in the report, is as follows:

"Because dams for the retention of hydraulic mining débris should be constructed, maintained, and administered by the California Débris Commission to insure the protection of navigable channels and lands below, and because of the benefits to the state by the revival of mining and other industries involved, it is recommended that the state and federal governments combine to provide the dams recommended.

"Payments made by miners for the retention of their débris by these dams will constitute a revolving fund for the continuance of their work under the control of the California Débris Commission under the provisions of Sec. 23 of the Caminetti Act of 1893.

"The recommendation now made is that a sum of $300,000 be appropriated for preliminary engineering necessary to obtain precise data upon those dam sites that give promise of favorable results upon Bear River, and the North Fork and Middle Fork of the American River, and to acquire the lands affected. Detail surveys are required on these sites and drilling to ascertain rock conditions to enable final estimates of dam construction to be calculated. If this work be started in the spring of 1927 it could be completed in that year. The preliminary estimates just completed indicate that a sum of approximately $905,000 will provide dams for twenty years of hydraulic mining on these streams. The gold production from this work is estimated to exceed $8,000,000 in that time. Payments by miners for débris stored during this period will automatically provide capacity for further work.

"In addition to the above it is recommended that storage be purchased in a dam to be constructed by a private corporation at the Narrows site on the Main Yuba River. The quantity offered for purchase is the total débris storage of a dam to be erected to a crest elevation of 520 ft. above sea level, some water space being reserved for hydroelectric power and irrigation purposes. The calculation of débris capacity will be subject to approval by the California Débris Commission in the usual manner. Preliminary estimates show 350,000,000 cu.yd. and a cost of $1,500,000. The balance of the cost will be carried by the power and irrigation features of the project. This is a much greater amount of storage than could be obtained for the same money at other sites surveyed on the Yuba. It will enable mines to work on both the South and Middle Yuba Rivers. The production for twenty years is estimated at $14,000,000 from about 130,000,000 cu.yd. of gravel. At the end of the twenty years there will still be space in this reservoir for another twenty years of work at the same rate.

"The storage would be vested in the California Débris Commission and would be paid for by mines operating behind the dams, according to the yardage of gravel washed each season, as measured at the mine, credit being given for material permanently stacked at the mine, the surveys being made by the commission or as directed by the commission. Power to purchase the time. Three hundred million cubic yards at $1,500,000 would be 0.5c. per cu.yd., which is low enough to insure the working of these low-grade gravels.

"This plan is feasible, and can be carried out at much below the capital cost involved in any other plan that has been suggested as a solution of the troubles of the hydraulic miner. It deals only with gravel that can be mined with the existing water supplies."

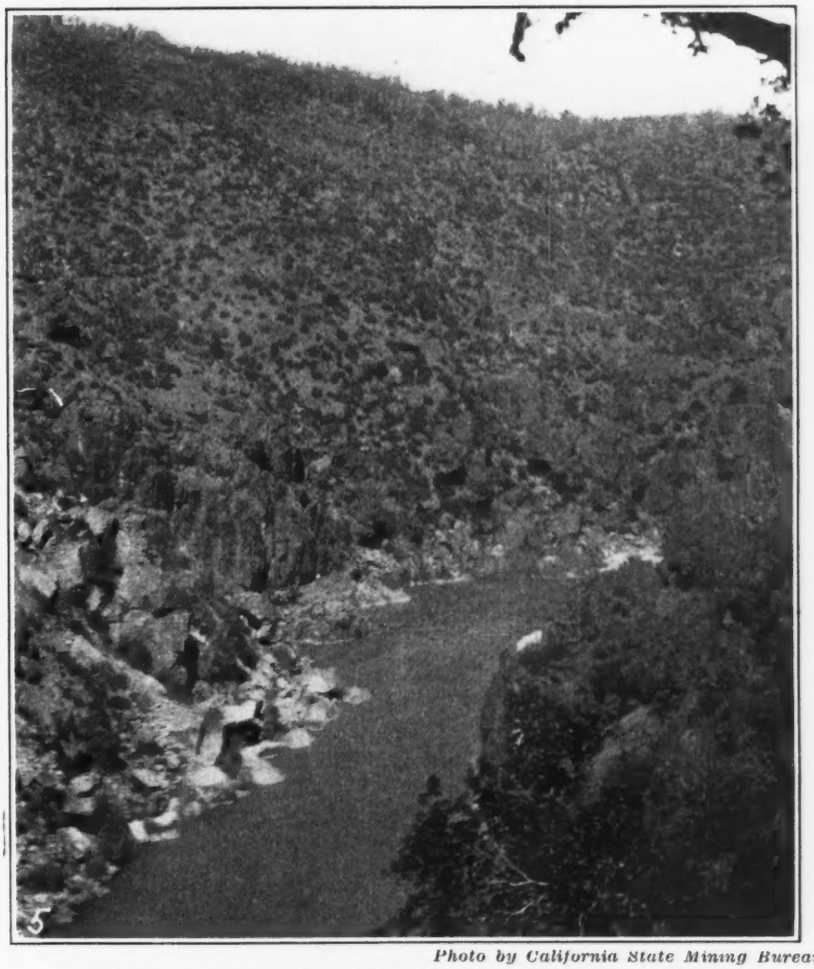


Photo by California State Mining Bureau

The Narrows on Yuba River where the proposed dam would impound 350,000,000 cu.yd. of gravel

débris storage in lieu of erecting a dam would have to be added to the Caminetti Act by Congress. It is also necessary to enact a new method of charging for impounding débris according to the actual volume of gravel discharged from the mine. The act now specifies a charge of 3 per centum of the gross output of each mine. This is so small that the dams would never be paid for.

"It is now suggested that the charge for each river be determined separately, the basis being the return of the capital outlay by the time the allowable débris has been worked above the dam. In this report the dams have been calculated to allow twenty years' work. In the case of the Main Yuba River at the Narrows it would take forty years of work at the rate calculated, but the development of extra water supplies and improvements in methods would speed up this work and reduce

Richmond Meeting, American Chemical Society, April 11-16

Water Purification and Softening will be discussed before the Industrial Division of the American Chemical Society at its meeting in Richmond, Va., April 11 to 16, when three half days will be devoted to a symposium on lime. Prof. J. R. Withrow, head of the department of chemical engineering of Ohio State University, is in charge of the program for the symposium and will preside.

Engineers Meet in Tulsa June 6

The next annual convention of the American Association of Engineers will be held at Tulsa, Okla., June 6 to 8, 1927. The convention will be held at the same time as the annual meeting of the Oklahoma Division, A. A. E. Members and friends of the association are invited to be present.

Recent Technical Publications

Reviews, Abstracts, and References

Practical Oil Geology in Its Fourth Edition

Practical Oil Geology. By Dorsey Hager. Fourth edition. McGraw-Hill Book Co., New York. Price $3.

This well-known book aims "to furnish the oil man with a clear, concise, and practical work on the occurrence of oil and its geology." Assuming that "the oil man" is any intelligent man interested in the oil business, this aim is probably covered as fully as possible within the limits of some 300 pages; and it is doubtful whether a more exhaustive treatise would meet the requirements so well.

This edition has been revised and improved by a more complete discussion of: Theories of origin, porosity of reservoir sands, core-drilling for structure, and the use of the seismograph and the torsion balance in exploration. An appendix includes useful tables and reference data and a bibliography of leading works on geology and petroleum engineering. Some of the prominent books are still listed in the old editions.

Evidently the author has not had in mind the layman in general, who may have some intellectual curiosity concerning the how and the why of petroleum. One must be versed in the language of the oil field to comprehend fully some of the chapters. The author might well consider the advisability of a glossary for future editions. Such simple terms as "rig," "liner," and "oil sands" may trouble the outsider who tries to look in. Even "dip" and "strike" are defined only at pages 124 and 126, although they are repeatedly used in preceding chapters. There is much evidence of hasty writing—a grievous fault of many technical men—and there are too many misprints for a fourth edition. The greater part of the book, however, may be read with profit by any intelligent reader, and it is commended to the young geologist and petroleum engineer as a convenient summary of the leading principles of exploration and exploitation.

Chapter 1, on the origin and accumulation of petroleum, outlines the leading theories and makes it clear to the reader that the origin of petroleum is still unknown. Unfortunately, the author's choice of words may give an unfair impression of the scientific man and his attitude toward theories. Only the charlatan "asserts" and "boldly states" that the origin of oil is thus and so. The author also indulges in the "bold assertion" that "oil is continually forming in buried beds" as a "result of heat and bacterial action." (page 5.) If we knew this, much of the preceding discussion of origin would be superfluous.

The excellent discussion of reservoir rocks (page 13) is likely to give the impression that oil accumulates only in sand. It is not explained that in the vocabulary of the oil man "sand" applies indiscriminately to any oil-producing rock—porous sandstone or dolomite, fractured limestone or shale, cavernous limestone, as well as actual beds of sand.

Chapter 2, on chemistry, is unavoidably technical. The genius who can present the complex chemistry of the hydrocarbons clearly to the non-technical public has not yet arisen.

In Chapter 3, on Stratigraphy, "igneous rocks" and "volcanics" are used as synonyms (page 36). Cross-bedding is said to be formed where currents "whirl the beds," which is picturesque but hardly scientific. Even cross-bedded sands are deposited from currents (air or water) that are no longer able to keep the individual grains moving, much less to "whirl the beds." Overlap and unconformity are repeatedly confused (pages 42, 44 and 45) and are not clearly distinguished in the definitions. The characterization of archeozoic as "without life" (page 56) is a contradiction of terms.

In Chapter 4, Structural Geology, folding is "thought to be the result of the contraction of the earth's surface due to internal cooling" (page 62). Contraction of the interior is obviously meant, but many geologists now repudiate this old hypothesis as inadequate. The axis of a fold is defined as a "longitudinal plane" (page 65), and similarly the axial plane, not the axis, is meant when the "hade or slope of the axis" of an overthrown anticline is described (page 144). "Normal dip" is the term uniformly applied to regions characterized by a prevailing dip in one direction, as in the mid-Continent (pages 73, 92).

In the description of salt domes (page 78) no reference is made to "cap-rock," although oil is said to "occur in the dolomite." Flanking sands are neither mentioned nor shown in the cross-section, but the driller is advised (page 138) to avoid the top and locate on the side. "Cap-rock" of quite a different kind is mentioned (page 19), referring to the impervious bed overlying the oil reservoir. The thrust fault is not named among the types of faulting, although it is illustrated (page 81) by a cross-section.

In Chapter 5, Prospecting and Mapping, "gas burns" and "burned-out shales" are named, without explanation, among indications of petroleum. It is startling to find the only mention of magnetic and electric prospecting methods among the "fakes" (page 103). Among geophysical appliances only the seismograph and the torsion balance are recognized (page 96) and only the latter is described under field instruments (page 258).

Chapters 6 and 7 discuss clearly the proper location of drilling sites and the leading factors in drilling, such as choice of rig, size of hole and casing, casing off quicksands and water. A "dry hole" is defined as one into which water must be put for drilling. The more common significance of the term is not mentioned (page 172). Some "dry holes" yield vast amounts of water.

Chapter 8, Factors in Oil Production, opens with the statement: "The aim of every oil operator is to extract the maximum of oil in the minimum of time and at a minimum cost." This should be qualified to apply only to areas of competitive drilling. More deliberate methods, with the object of conserving gas pressure and recovering the maximum ultimate yield, prevail in non-competitive exploitation by the larger oil companies. Probably few geologists and petroleum engineers will accept the estimate of 50 per cent average recovery from oil sands. Indeed, 20 per cent may be too high. There is reason to believe that commercial recovery in many fields has failed to reach even 10 per cent.

Chapter 9 is appropriately headed "Water, the Enemy of the Petroleum Industry." Under methods of testing for the source of water entering a hole, the successful electric device perfected in California is omitted. Pressure of mud-laden fluid in the well is given in pounds "per cubic inch." The same slip is repeated in discussing gas pressures (pages 218, 223).

Chapter 10 deals with Natural Gas and Casing-head Gas, and Chapter 11 with Oil Shales. In Chapter 12, Geological Field Methods and Instruments, the only methods described for determining dip are by the use of the stadia hand level or the aneroid barometer. It is not explained that these are of limited application and that other methods are widely used.

Chapter 13, What the Geologist Has Done for the Oil Business, gives an interesting summary of the results of geologic methods, apparently for the purpose of combating the lingering prejudice of some "practical oil men" against geologists. Such men, however, will not read this book. Besides, they are more likely to be impressed by the practices of successful oil corporations than by any argument presented by the geologist.

Despite minor slips and debatable points, the mere mention of which tends to overemphasize them, the subject-matter of the book is well chosen and, on the whole, clearly presented. It undoubtedly has decided value for the man who desires a general knowledge of oil geology. Nevertheless, the book belongs to the large class of technical works which furnish ground for the oft-repeated charge that scientists neglect the English language—do not learn to use it clearly, accurately, and with a discriminating sense of the value of words. We are accused of being so eminently "practical" or "scientific" that we ignore this most valuable tool and medium of communication. In large measure we must plead guilty to the charge. J. VOLNEY LEWIS.

South Australia—The annual report of the Director of Mines and Government Geologist for 1925, pp. 9, is now available from the Department of Mines, Adelaide, South Australia.

Queensland — The annual report of the Under Secretary for Mines, on 1925, pp. 127, was recently issued by the Department of Mines, Brisbane, Queensland. The price is 3s. 6d. Copper, lead, and tin ores are mined to some extent in this province.

People You Should Know About

A vacancy will shortly exist on the editorial staff of *Engineering and Mining Journal*. Applications will be considered from young graduate mining engineers who have had three or four years' practical experience in mining districts. Applicants should address the Editor, *Engineering and Mining Journal*, 10th Ave. at 36th St., New York, N. Y.

R. W. Brigstocke, mining engineer, has moved his offices to the Guarantee Building, Toronto.

W. Smith has resigned from the management of the Barry-Hollinger Mines, in the Kirkland section.

J. Volney Lewis has resigned as professor of geology at Rutgers University to engage in private consulting work.

George A. Denny, formerly consulting engineer to the Albu group of mines, has arrived in Johannesburg from Rhodesia.

S. M. Soupcoff, engineer for the American Smelting & Refining Co., visited South Dakota during the latter part of February.

Ernest Gayford, vice-president and secretary of the General Engineering Co. of Salt Lake City, Utah, spent part of February in California.

Philip D. Wilson, mining engineer and geologist, with the American Metal Co., has returned to New York from an extended trip to South America.

F. C. Hicks visited the Tintic Standard mine, at Dividend, Utah, recently, to investigate the efficiency of the Butler mechanical shovel in operation there.

W. H. H. Crammer, Union Oil Co. land-office official, has resigned to take charge of drilling a structure for himself and private interests in San Juan County, Utah.

C. D. Fleming has been appointed Acting Secretary of the Department of Mines and Public Works of Southern Rhodesia during the absence on leave of **A. C. Bagshawe.**

Philip North Moore was the guest of honor at a banquet tendered to him by his engineering colleagues on March 5 at the Engineers' Club, 4359 Lindell Boulevard, St. Louis, Mo.

James Cullen, formerly with the Mexican Corporation at Freznillo, Zacatecas, Mexico, is now with the San Francisco Mines of Mexico, at San Francisco del Oro, Durango.

W. H. Corbould has returned to Australia, after an absence of some months in England, on a mission connected with the financial arrangements of Mount Isa Mines, Ltd., Queensland.

William Sloan, Minister of Mines for British Columbia, who has for some time been in ill health, has been ordered a complete rest by his physician and will not be able to take part in the proceedings of the Provincial Legislature during this session.

S. G. Turrell, mining engineer of Melbourne, Australia, has been a visitor in New York for several weeks. He will visit northern Ontario and sundry mining districts in the eastern part of the United States before returning to Australia.

Thomas Varley, superintendent of the U. S. Bureau of Mines at Salt Lake City, has been granted leave of absence to conduct a series of tests on ores for foreign companies. During Mr. Varley's absence, **R. E. Head,** assistant superintendent and miscroscopist, will be acting superintendent. In the interim, Mr. Varley will make his headquarters in Salt Lake and act as a consulting

Thomas Varley

metallurgist to the Bureau and complete his report on "Flotation Agents During 1926." Mr. Varley has been retained to perform a series of tests on the copper-iron-zinc ores of the Sulitelma Copper Co. of Stockholm, Sweden, which operates a group of mines just within the Arctic circle in Norway. Concentrate is shipped by water to Stockholm for pyritic smelting. Experiments will also be conducted on Bolivian tin ores of the Compania Estanifera, operating large tin mines at Cerro Grande, Bolivia. Mr. Varley will also check up on the metallurgy of the new flotation plant of the Pioche Mines Co. before it goes into operation in the spring at Roche, Nev. Mr. Varley, who is a graduate of the University of Utah, was in charge of ore testing for seven years for the American Smelting & Refining Co. and the Federal Lead Co. In 1917 he joined the Bureau as metallurgist at Moscow, Idaho. For a time he was in charge of the Seattle station. In 1919 he came to Salt Lake to take charge of the Salt Lake station as superintendent.

Kjell Lund, general manager, and **Arne Forfang,** concentrator superintendent of the Sulitelma Copper Co., of Stockholm, Sweden, recently spent several weeks visiting Utah metallurgical plants. From Salt Lake City Mr. Lund and Mr. Forfang went to Arizona to inspect operations in copper metallurgical plants.

Richard Treloar has been appointed manager of the Hollinger mine, at Boston Creek, in the Kirkland Lake area of northern Ontario. Mr. Treloar was formerly on the staff of John Taylor & Sons, London, and was recently engaged at the Central Manitoba Gold Mines, in which that company are heavily interested.

Angus Campbell has been appointed manager of the Castle-Trethewey Mines, Ltd. Mr. Campbell has been assistant general manager of the O'Brien mine, at Cobalt, and the Millar Lake O'Brien mines, at Gowganda. He is replacing **Horace G. Young,** who resigned to become manager of Howey Gold Mines, Ltd.

Mr. and Mrs. Robert Raine celebrated their golden wedding at their residence, Rokeby, Muizenberg, near Capetown, South Africa, on Dec. 27, 1926. They came to South Africa in 1881 and settled at Salt River for eight years. Going to the Rand in 1889, Robert Raine was appointed engineer, then manager, of the New Heriot and later of the Village Main Reef gold mine. For some years he was M. L. A. for the Ophirto division of Johannesburg.

Obituary

Sir W. Gwynne Evans, a South African pioneer, died recently in London, at the age of eighty-one.

Lewis Frickman, mining engineer of Toronto, died on Feb. 26 at the age of forty-five years. He was born in Germany and received his education at the Heidelberg University. Mr. Frickman spent many years in the practice of his profession in northern Ontario.

John Arthur Porter, mining engineer and one of the oldest members of the A.I.M.E., died recently. Mr. Porter was born in Connecticut and was educated at Freiberg, Saxony. He had practiced his profession in the West for a long period, before retiring from business life some years ago.

Henry Schepers, aged sixty-one years, foreman at the Mabel mine, 20 miles westerly from Mina, Nev., was instantly killed in an accidental fall from the 300 to the 500 level of the vertical shaft on Feb. 21. No one was present when the accident occurred, but it is thought that Schepers, on his arrival at the 300 level, released the cage, forgot that he had released it, and stepped back into the shaft instead of, as he expected, into the cage. He was an old resident of Nevada and had been employed at the Mabel mine for about a year.

A. R. Wilfley, mining engineer, known for his inventions and recognized as an authority on ore treatment, died on Feb. 20, 1927, at Whittier, Calif. Mr. Wilfley went to Colorado from Missouri and located at Kokomo, Colo., where he made his first experiments leading to the invention of the Wilfley concentrating table, in 1896. He later perfected a sand and slime pump which was widely adopted. Mr. Wilfley was extensively interested in mining enterprises. He was a great lover of art, and took pleasure in collecting Oriental rugs, brasses, and porcelains. Some time ago he presented to the Denver City Park Museum an exhibit of Chinese art which is considered one of the finest in the country. He is survived by his wife, two sons, George and Elmer, and a daughter.

New Machinery and Inventions

Handling Flotation Concentrates at the Mill of the Utah-Apex Mining Co.

By Albert L. Genter

WHEN the Utah-Apex mill at Bingham, Utah, was enlarged to provide for the differential flotation of lead-zinc and lead-copper ores, several difficult problems were encountered and solved. One of these problems was finding proper room for new thickeners and filters.

In view of the fact that the capacity of Genter thickeners having tanks 9 or 12 ft. in diameter is ordinarily equivalent to that of decantation tanks having diameters five or six times greater, it was decided to install these thickeners for handling the concentrate froth from the lead-zinc and lead-copper flotation sections of the mill. This decision also involved the following advantages:

1. It made possible the use of the decantation thickeners already present for additional tailings thickeners.
2. It meant lower excavation and installation costs in the narrow and steep canyon.
3. It permitted installing thickeners, storage tanks, and vacuum filters over the present concentrates bins.
4. It made possible the return of perfectly clear water from the thickeners to the flotation plant.
5. It insured a constant heavy pulp feed to the continuous filters.
6. It eliminated the old method of transporting concentrates in cars from the mill to the storage bins.
7. It permitted making the entire additional installation without interrupting operations in the main mill.

The thickening and filtering plant was located some 600 ft. down the narrow canyon from the main mill; and the remaining problem was therefore to transport the flotation products in diluted condition to the filter plant. As the level of the latter plant is approximately the same as that of the main mill, it is evident that using slightly inclined launders for transporting dilute flotation froth involved an element of danger. It was, therefore, decided to pump the froth from the Callow and MacIntosh flotation cells to an elevation of about 30 ft. above the flotation section of the mill and then let the pumped product flow downwards through small pipes to the filter plant. The slope of pipe was about a half inch to the foot. Small pipes of 2, 2½, and 3-in. diameter were chosen to insure high velocities of thickener feed. This would prevent the coarser mineral particles from settling in the piping system.

The ultimate daily capacity of the present filter plant is to be 200 tons of dry lead concentrates, 70 tons of zinc concentrates, and 40 tons of copper concentrates. The feed to the lead thickener contains six parts of water to one part of solids, and that to the zinc and copper thickeners five parts of water to one part of solids.

Three-inch Wilfley pumps were chosen for pumping the lead, zinc, and copper flotation froths. Standard 3-in. pipe is used to convey the lead concentrate froth to the filter house. The feed pipe for the zinc is 2½ in. in diameter and the copper flotation froth is pumped through a 2-in. line. The three pipe lines between the mill and filter house are carried on a trestle. These pipe lines have showed no signs of plugging after four months of operation.

THICKENING AND FILTERING

The accompanying drawing shows the plan and sectional elevation of the filter house. The three thickeners are on the highest level and the thickened sludge from each flows by gravity through a special mud valve to the concentrate storage tanks on the next lower level. These tanks are all 16 ft. in diameter by 10 ft. deep, are equipped with agitators running at 10 r.p.m., and hold sufficient thickened concentrates for about eighteen hours' thickener operation. Thickened pulp from the tanks flows by gravity to continuous vacuum filters on the level below.

The lead concentrate filter, made by the Industrial Separators Co., of New York, is a drum-type continuous vacuum filter and is 11 ft. 6 in. in diameter by 10 ft. long. It handles about 100 tons of dry lead concentrates in eight hours.

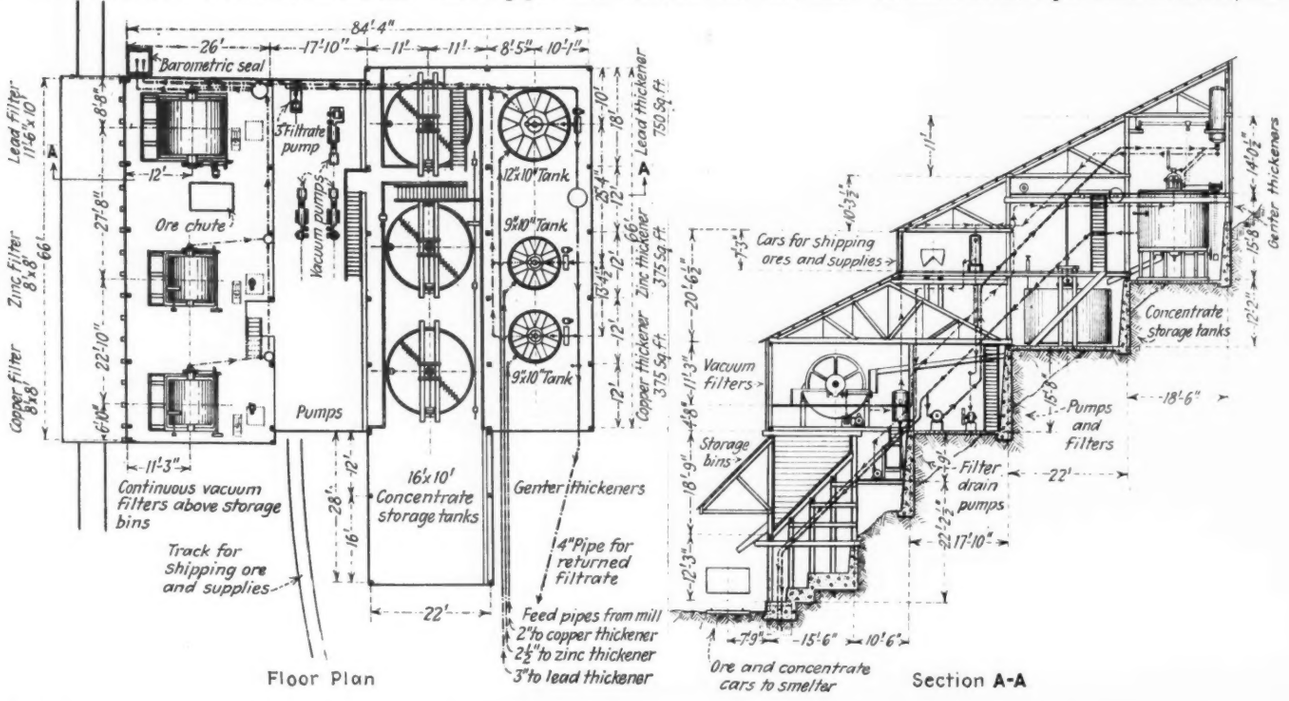
Zinc and copper concentrate filters are also drum-type continuous vacuum filters 8 ft. in diameter by 8 ft. face. They also operate eight hours out of every twenty-four.

The thickeners therefore operate continuously and the continuous vacuum filters, after the storage tanks are is possible to run the entire thickener and filter plant with one man per shift. This single operator cares for all machinery and equipment.

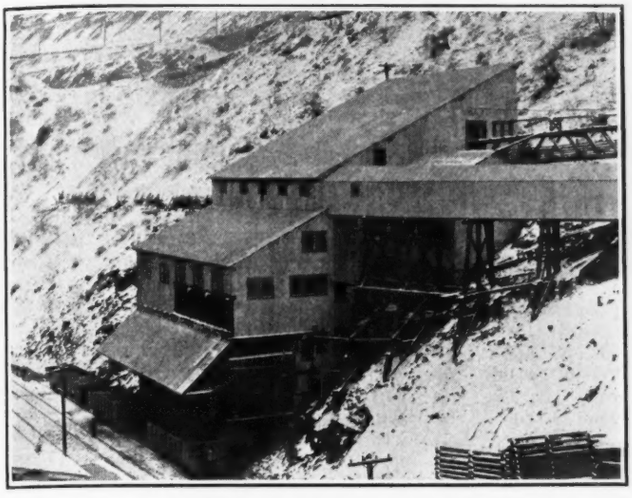
Any drainage from the individual filters, after the storage tanks are emptied, is returned to the thickeners or storage tanks by means of motor-operated 2-in. Wilfley pumps situated below the filters.

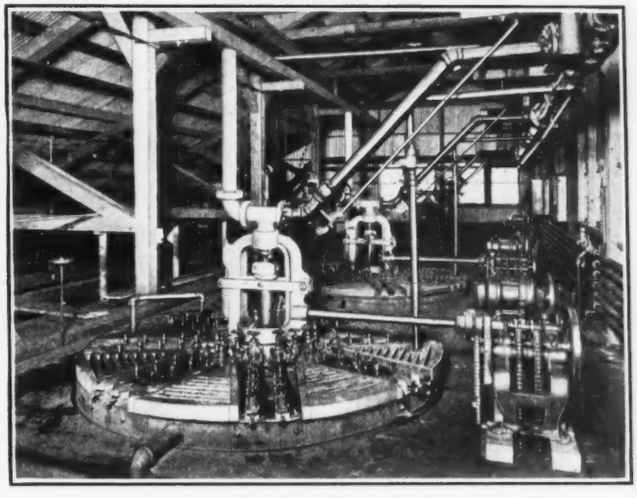
All three concentrate filters discharge their dewatered products into the concentrate bins directly below the filters.

The lead filter cake contains about 8 per cent moisture; the zinc filter cake contains about 9 per cent moisture, and



Plan and sectional elevation of filter house, Utah-Apex mill, Bingham, Utah





Left—Thickener and filter house, Utah-Apex mill, Bingham, Utah. Right—The thickeners

the copper filter cake about 12 per cent moisture.

The Consolidated Mining & Smelting Co. of Canada was largely instrumental in developing the Genter thickeners for metallurgical purposes. *Engineering and Mining Journal-Press* of July 11, 1925, contains an account of the thickeners in that company's plants and also a complete description of their construction and operation.

As the Genter is a filter thickener, the filtered effluent is withdrawn from the center of the apparatus either by means of a barometric leg or a convenient pump. Both provisions are made at the Utah-Apex plant. As before stated, all three thickeners are located on one level in the filter house. The lead thickener has thirty-two frames grouped about the central valve and receiver in a 13-ft. wooden tank. The zinc and copper thickeners have sixteen frames each grouped about their respective valves and central receivers in 9-ft. diameter tanks. Each thickener frame contains four tubular filter elements about 4 in. diameter by 6 ft. long, covered with tubular socks of cotton fabric. The tubular elements are held in each frame by compression springs and the frames in turn held against the central stationary valve housing by a compression member.

The crystal-clear filtrate from all three thickeners under suction from the filtrate pump below is drawn through the elements and frames to the central valve housing and receiver of each thickener and finally reaches the pump below, as all three receivers of the three thickeners are connected to one filtrate-removal header.

The filtrate pump used is a 3-in. double-suction volute Cameron pump, motor-driven, and operates at a speed of 1,750 r.p.m. It returns the clear water to the main mill. Its discharge pipe passes above the thickeners and through a pressure-release valve before going to the main mill. This valve maintains any desired pressure on the pump discharge header above the thickeners, which pressure is stored in a hydro-pneumatic tank. It is then used as a means of automatically removing the cake of concentrates from the filter elements in each thickener. For this purpose a branch pipe leads from the filtrate header to the central valve of each thickener.

A motor-driven timing mechanism at the side of each thickener periodically shifts a cut-off plug within each valve housing so that two of the frames in each thickener are cut off for two seconds from the suction existing in the central receivers, and filtrate under the pressure stored in the pump discharge header is allowed to hammer back to the interior of the two frames in question and suddenly shock or flush the concentrate sediment from the exterior of the eight elements belonging to these frames. The timing mechanism then suddenly shifts each plug to a neutral position where all elements are filtering. The plugs are then caused to shift suddenly to the following two frames, so as to remove the sediment from their elements. In time the automatically shifting plug in each thickener has made a complete rotation and cleansed all elements in use. This rotation time or cycle at the Utah-Apex plant is about four minutes, or 240 seconds, and the time each group of elements is not filtering but is being cleansed of sediment during this cycle is about two seconds out of every 240 seconds. Consequently, the capacity of the filtering surface is not only large, but the countercurrent shock is on so few elements and of such short duration and free from disturbance, because water and not air is used, that the contents of each tank are not disturbed and settling takes place to aid filtration further. This quite naturally results in large capacities for the small sizes of tanks installed.

Unthickened feed is fed through the side of every tank against a baffle.

The concentrate sludge, composed of cake discharge from the elements in submergence and solids that naturally settle, is heavier than sludge composed of settled material only. It is raked toward the center bottom outlet by means of revolving scrapers held on a shaft penetrating a gland in the bottom of each thickener. As this shaft revolves very slowly—one minute per revolution—there is practically no wear on it, and the gland lasts indefinitely. The worm drive is actuated from the motor above that also drives the mechanism that periodically shifts the central valve plug for cleansing successive element groups. Thickened product flows through a novel conical gate valve that has an orifice of constant shape but of any desired size. As before stated, the thickened product flows by gravity to the concentrate storage tanks and contains from 60 to 70 per cent solids.

The capacity of each thickener is made flexible by using a gate valve between every frame and the central automatic master valve and receiver. This enables the operator to open as many frames as he desires to handle the tonnage desired. The balance is kept closed. This eliminates any overflow return from the thickeners.

Ordinarily, eight of the thirty-two frames on the lead thickener will handle 80 tons of dry lead concentrate per twenty-four hours from a feed having six parts water to one part of solids with the vacuum gage registering 14 in. If it is desired to operate at a lower vacuum, more frames can be used. As there is a small vacuum line from each thickener connected to the continuous filter vacuum system for removing entrained air that the volute filtrate pump will not remove, the valve in this vacuum line is cracked sufficiently to keep the vacuum around seven to ten inches of mercury. This necessitates using half of the frames in all thickeners.

As one operator cares for the entire filter plant, he occasionally looks over the level of the feed in the thickeners, and if it is below the tops of the elements he will shut off another frame or so from the particular thickener in question. This keeps all elements submerged and eliminates air entering the system and naturally increases the vacuum produced by the volute pump removing the filtrate from the thickeners. It is obvious that a float signal system could be used to call the operator's attention to the fact that more frames had to be opened or shut off; however, the variation is so very slow that such a system is not necessary with the installation in question.

As 850 tons of water enters the plant with every 150 tons of lead, zinc, and copper concentrates and 13 tons of water go out with the concentrates as moisture, and 87 tons of water removed

Water and Concentrates Entering and Leaving Thickener and Filter Plant Daily When Dewatering 100 Tons of Lead Concentrate, 30 Tons of Zinc Concentrate, and 20 Tons of Copper Concentrate

Thickeners			Filters				
Feed		Filtrate Returned to Mill, Tons, Water	Underflow		Filter Cake		Water Removed and Lost, Tons
Concentrates	Water, Tons		Concentrate, Tons	Water, Tons	Concentrate, Tons	Water, Tons	
100 tons lead	600	530	100 Pb	70	100	8	62
30 tons zinc	150	135	30 Zn	15	30	3	12
20 tons copper	100	85	20 Cu	15	20	2	13
150 tons concentrates	850	750	150 concentrates	100	150	13	87

from the thickener underflow by the filters is allowed to escape through the barometric seal, the water loss is 100 tons per day, or about 11.8 per cent of the total water entering the thickener and filter plant. The balance of 88.2 per cent, or 750 tons of water, is returned to the main plant for re-use. If the water removed by the vacuum filters from the Genter underflow were also returned to the mill for re-use, there would be only 13 tons of water lost out of every 850 tons. This would mean about a 98.5 per cent recovery of the water entering the plant.

As the flotation pulp enters the lead thickener containing about 14 per cent solids and 85 per cent water, and the sludge leaves the thickener with approximately 59 per cent solids and 41 per cent water, it will be seen that this thickener eliminates about 89 per cent of the water in the original feed as a crystal-clear product.

The flotation pulp flowing to the zinc and copper thickeners contains about 17 per cent solids and 83 per cent water and the thickened discharge about 60 per cent solids, so that the elimination in these thickeners is about 87 per cent of the water entering the thickening system. This water is also as clear as drinking water and, as before stated, is returned to the main mill for re-use.

Filtered water from the vacuum filters is about 10.2 per cent of the entire water entering the filter house. This is not returned to the main mill at present, because it would necessitate either the installation of another return pump or lowering the present filtrate return pump and increasing the head against which it operates in returning water. The filtrate from the present vacuum filter receivers is therefore sealed some 30 ft. below the filter floor and overflows the seal to the creek in the canyon.

The suction line for the filtrate from the thickeners to the return filtered water pump is bypassed to this same seal also and is cut off from the seal by a gate valve. This is an emergency bypass and is used only in case repairs are required on the 3-in. motor-driven volute pump. This eliminates the necessity of installing a spare return water pump. In such an emergency all the clear water would run down the creek. The small amount of water then necessary for cleansing the filter elements is obtained from an auxiliary water line connected to the filtrate header.

At present the lead thickener is handling about eighty tons of dry lead concentrates every twenty-four hours. The filter area used will average 300 sq.ft. during the life of one dressing. This means a capacity of about 0.3 tons of dry concentrate per square foot of cloth area per twenty-four hours and a filtered water capacity of about 0.4 per square foot of cloth per minute on a feed containing six parts water to one part of solids.

The zinc thickener is handling 30 tons of dry zinc concentrates every twenty-four hours and has about the same capacity in tons of solids for every twenty-four hours as has the lead thickener. The same is true of the copper thickener.

As the cloths gradually blind with collodial material, especially from colloidal silicates present in the lead concentrates, the element cloths are occasionally brushed to revive them. This is accomplished by lifting a frame out once a shift, quickly removing four tubes by lifting their springs and inserting spare elements that have been brushed in their place, and putting the frame back in the thickener. The removed tubes are then set aside and later brushed when dry. This requires but a few minutes each shift.

Cloth life is about four months at present. The cost normally amounts to 1c. per ton of concentrates treated in the thickener. Of course, this cost per ton would be materially reduced if the thickeners were handling their full capacity.

Power Consumption

Power consumption for operating the timing mechanisms and rakes is about 3 hp. for all three thickeners. That required for returning the filtered water to the main mill amounts to about 9 hp. at present and should hardly be charged against the thickener operation. The water is needed in the mill and would have to be returned from any other thickening system.

The total filtering area of the continuous vacuum filters is about 760 sq.ft. About 980 cu.ft. vacuum pump displacement is available for the entire filter plant. This is obtained from two 12x6-in. vacuum pumps formerly used for the lead and zinc filters in the old plant and a new 18x6-in. vacuum pump purchased with the new large filter. Ordinarily, only two of these pumps are used and one is held as a spare.

Power consumption for maintaining suction on the vacuum filters never exceeds 15 hp. during the six hours the continuous filters are running. The average amount consumed for the stirrers of the concentrate storage tanks which run continuously is not more than 9 hp.

The vacuum filters, with their agitators, consume about 12 hp. while running eight hours every day. This will include the small amount of power going into the compressed air used for cake discharge.

Power cost in the entire filter plant is now about 3c. per ton of concentrates, including the cost of returning the filtered water.

The labor required for the entire plant is, as before stated, one man per shift. Labor cost is therefore about 10c. per ton of concentrates treated at present. In view of the fact that the vacuum filters run but eight hours out of every twenty-four, and the thickeners are not run to full capacity, it will be seen that this amount of labor can be distributed over a large tonnage when conditions require, and the labor cost per ton of concentrates handled will be reduced.

Assuming that cloth and other maintenance costs amount to 3c. per ton of concentrates handled, the total cost per ton for power, labor, and maintenance is 16c. per ton when handling about 130 tons of concentrates as at present. If the tonnage of the plant were doubled, these figures would be reduced to about 10c. per ton.

An Automatic Sump Pump

The new automatic sump pump manufactured by the Buffalo Steam Pump Co., Buffalo, N. Y., and used for draining pits, cellars, and excavations, is said to offer five particular advantages: (1) It is easily installed, being a self-contained unit which upon arrival needs only to be uncrated and connected to the electric current supply; (2) the motor shaft and pump are entirely inclosed and positively protected from action of sump water; (3) all parts are easily accessible; (4) ball-bearing thrust is used to carry the weight of the moving parts, and is adjustable to conditions of alignment; (5) oil in place of grease is used to lubricate the thrust, since it is claimed to be far superior for the intermittent use to which the bearings are subjected.

Trade Catalogs

Locomotive Headlights — Crouse-Hinds Imperial incandescent headlight for mine locomotives. Ohio Brass Co., Mansfield, Ohio, agents. Bulletin 219. Pages 4.

Material Handling—Western Wheeled Scraper Co., Aurora, Ill. A handsomely illustrated "jubilee" catalog of 168 pages, covering the company's line of earth- and stone-handling equipment and, at the same time, commemorating the fiftieth anniversary of the founding of the company. It is entitled "Fifty Years of Service."

Filters—United Filters Corporation, 17 East 42d St., New York. Bulletin 130 covering the American continuous filter. Pages 38.

Oxygen Manifolds — Air Reduction Sales Co. Catalog Section 6, covering Airco Davis-Bournonville oxygen manifolds. Pages 8.

Testing Machine—Riehle Bros. Testing Machine Co., 1424 North 9th St., Philadelphia, Pa. Pages 18.

Market and Financial News

International Nickel Earnings Same in 1926 as in 1925

Net Profit Equal to $3 a Share on Common, Compared With $2 Dividend—Operating Costs Lower—Foreign Business Sought

TOTAL NET EARNINGS of the International Nickel Co., operating nickel-copper mines and a smelter in the Sudbury district of Ontario, a refinery at Port Colborne, Ont., and a rolling mill at Huntington, W. Va., were $5,556,267 for the year 1926, compared with $5,527,484 for 1925—practically the same. Sales of metallic nickel were less than during 1925, owing principally to a decrease in European demands, but this deficiency was more than made up by an increase in the volume of business done in Monel metal and rolled nickel, products of the company's mill. In the last year or two, large quantities of nickel steel armor and deck plate scrap, resulting from the disarmament program, have been consumed by the alloy steel manufacturers. This has taken the place of virgin metal, but it is thought that competition from this source will soon be at an end.

A large amount of high-grade ore has been developed at the Frood mine, where shaft sinking is in progress; it is planned to have this mine in active production for the metallic nickel requirements of the company, within five years, and to reserve the Creighton mine as the source of ore for Monel metal. No data are given on ore reserves, but it is generally thought that the company's properties assure an adequate supply of ore for a hundred years or so. The company's 22 miles of railroad at Copper Cliff have been electrified, and many improvements have been made at the Port Colborne refinery, so that a much larger proportion of metal is now electrolytically refined, securing nickel of high purity and increased recovery of platinum group metals. Over a million dollars was spent in a new strip mill department and additional mill equipment at Huntington. The company's properties in New Caledonia have been disposed of, as the deposits there are considered of little importance compared with those in Ontario.

The fiscal year of the company now coincides with the calendar year, instead of ending on March 31 as heretofore. Operating profit for 1926 was $7,191,283, from which was deducted $1,072,237 for depreciation of plants, $456,625 for depletion of ore reserves, and $106,155 for Orford Works property expense, leaving a net profit of $5,556,267. After deduction for preferred dividends ($534,756) and common dividends ($3,346,768), and adjustment due to disposal of New Caledonia properties, amounting to $296,354, the surplus on Dec. 31, 1926, was $16,680,482. Earnings applicable on the common stock were $5,021,511, equivalent to $3 per share for the year. Dividends on the preferred were $6, and on the common, $2, per share.

The balance sheet shows that the additions to property account, less recoveries and value of foreign companies, were $1,893,443, and that $93,168 was written off for dismantlement and charged to reserve fund. The total property account, after deducting depreciation and depletion of ore reserves, is $53,424,609, compared with $53,060,027 on Dec. 31, 1925. Net current assets of $15,531,017 are in excess of last year's figures by $475,883.

Net profits of the International Nickel Co. for recent years are as follows, that for 1926 being for the calendar year, and those for preceding years being for the fiscal year ending March 31:

1921-2	1922-3	1923-4
a$797,747	$48,170	$1,206,787
a Deficit.		
1924-5	1925-6	1926
$2,924,058	$5,603,974	$5,556,267

Robert C. Stanley, president of the company, mentions the use of nickel for improving cast iron, which "is advancing satisfactorily and in time should provide an outlet for a large tonnage of metallic nickel." An organization is being built up to develop the use of nickel in Europe, as has been done in America; this was made advisable by a falling off in export sales. The "company has no serious problems to face in the immediate future. Products are constantly improving in quality and operating costs are being satisfactorily lowered. Your management has every reason to believe that the company is still in a period of constructive expansion which its established sales methods are well designed to promote and which should not be checked by anything less than acute and widespread business depression."

A fairly complete list of uses of nickel and Monel metal is appended to the report.

On Dec. 31, 1926, there were 89,126 shares of 6 per cent non-cumulative preference stock, $100 par, outstanding, in the hands of 1,433 shareholders. Of the common, there were 1,673,384 shares, $25 par, outstanding at the end of the year, distributed among 11,162 shareholders.

Robert C. Stanley is president; James L. Ashley, vice-president; and Charles Hayden, chairman of the board. The head office is at 67 Wall St., New York City.

	1926	1925	1924	1923
Gross revenue	$6,330,752	$6,706,647	$6,308,624	$6,445,033
Other income	304,527	280,897	314,867	329,198
Total income	$6,635,279	$6,987,544	$6,623,491	$6,774,231
Mining expense	2,784,132	2,984,072	3,294,019	3,006,837
Other expense	620,665	652,139	470,578	663,757
Depreciation and depletion reserve	2,980,168	2,974,913	3,006,383	2,852,316
Net profit	$250,314	$376,420	(a) $147,489	$251,321
Dividends	3,150,000	2,362,499	2,625,000	3,675,000

(a) Loss.

United Verde Extension Profit Decreases

Earnings in 1926 Equal Only 23c. a Share, Compared with 35c. in 1925

The annual report of the United Verde Extension Mining Co., operating copper mines and a smelter at Jerome and Clemenceau, Ariz., respectively, shows a net profit for 1926 of $250,314, after charges, depreciation, and depletion. This is equivalent to 23c. a share on the 1,050,000 outstanding shares of the company (par 50c.), and compares with $376,420, or 35c. a share, in 1925.

In 1916 the company mined 199,671 tons of ore, averaging 10.61 per cent copper, 0.042 oz. gold, and 1.78 oz. silver per ton, which was smelted direct in the company's smelter. Copper production amounted to 43,071,576 lb., indicating a smelter recovery of 98.7 per cent. The cost of this copper, before depreciation and federal taxes, is given as 6.47c. a pound.

Development work to the westward on the upper levels of the United Verde Extension has proved the extension of the orebodies mentioned in previous reports. Work on the 1,800 and 1,900 levels has not as yet opened ore of commercial grade, but it is stated that there is reasonable expectation that ore will be developed as exploratory work progresses.

Development work in Jerome Verde ground has been completed without finding ore. The present ore reserves are said to be equal in tonnage and grade to those of two years ago, but actual figures are withheld, owing, it is said, to their having been used in the past against the interests of the stockholders.

Of the $3 per share in dividends paid in 1926, 37.53c. was appropriated from earned surplus, and $2.6246 a share was applied to dividends from depletion reserve account.

The income account for each of the last four years, with condensed financial statement, is as follows:

Mr. Douglas states that the company has started development work on the Bisbee Queen group of claims in the southern end of the Warren mining district in Arizona, and that the company will sink a shaft with as little delay as possible. The company is also about to begin prospecting for the northern extension of the Noranda deposit in the Rouyn district of Quebec, where it has taken an option, and it may undertake certain other work elsewhere. Mr. Douglas adds that it is not probable that these operations will affect surplus account seriously nor reduce present dividend rate, as the contemplated expenditures will not be large until ore is discovered.

James S. Douglas is president of the company, with office at Douglas, Ariz., and George Kingdon is general manager at Jerome. The head office of the company is at 233 Broadway, New York City.

A. S. & R. Reports $17,760,721 Earnings

Extra Dividend Forecast If Metal Markets Stiffen—$7,581,629 Spent for Improvements

American Smelting & Refining Co. during 1926, after provisions for charges of every kind and dividends on the preferred stock, amounting to $3,500,000, earned nearly twice as much as in 1924 and $2,568,000 more than in 1925. The figure is $14,260,720, or $23.38 per share of outstanding common stock.

A detailed comparison of income for 1925 and 1926 is shown in the accompanying table.

Fnnancial Statement

Year	1926	1925
Total net earnings	$28,655,133	$26,762,845
Other income	1,496,159	1,215,780
Total income	$30,151,293	$27,978,625
General expenses, taxes	$4,027,404	$3,898,687
Interest, depreciation	8,363,167	8,889,178
Net income	$17,760,721	$15,190,760
Dividends	8,074,850	7,464,870
Surplus income	$9,685,871	$7,725,890

The lower prices for silver reduced earnings somewhat in the last quarter, as did also the slump in lead and zinc prices. Lower metal prices at the beginning of this year compared with 1926 also resulted in an appreciable inventory loss. All these causes are estimated to have reduced earnings in the second half almost $2 a share on the common stock compared with the first half year.

Plants of the company operated at high capacity throughout the year. Since the first of the year the company has, because of low price of lead, and the state of overproduction that exists taking the world as a whole, reduced lead output from its mines in Mexico about 15 per cent.

The company has just started its smelter at Quiruvilca, Peru. This is a copper plant receiving ores from the company's own mines. Its operation should increase Peruvian earnings appreciably this year.

Though there has been some talk about the company's paying an extra dividend of $1 a share at the April meeting of directors, nothing other than the regular dividend on the common stock should be expected.

Probably the company will, on account of its high rate of earnings, increase the disbursements on the common stock, but this is not to be expected until later in the year, when it is hoped the lead, zinc, silver, and copper markets will improve. This increase, when it occurs, probably will take the form of an extra dividend, probably semi-annually, instead of an increase in the rate of the regular quarterly dividend.

Expectation of an extra dividend at the next dividend meeting or an increase in the rate has undoubtedly had some influence in the recent advance in American Smelting common shares.

In his report to the stockholders President Guggenheim says: "Your company is in a strong cash position, having on hand at the end of the year, in cash, call loans and U. S. Government bonds and notes, $34,519,784.20, a gain of $9,243,789.96 over the preceding year, which corresponds quite closely with the gain of $9,685,871.16 in surplus before the appropriations for reserves. The company expended during the year, in new undertakings, enlargements, and betterments, the sum of $7,581,629.22, without additional financing.

"Total current and miscellaneous assets made a gain during the year of $1,062,095.13 and stand at $97,125,157.03, almost five (4.937) times total current and miscellaneous liabilities of $19,674,359.99. As total current and miscellaneous liabilities decreased during the year in the sum of $1,658,607.02, the actual gain in net current assets was $2,720,702.15. The common dividend, which was increased from 6 per cent to 7 per cent in 1925, was further increased to 8 per cent in 1926."

Principal metal products of the company in 1926 were:

Copper, tons	525,897
Lead, tons	469,607
Gold, oz	1,634,158
Silver, oz	85,482,438

During 1926 the company had in its employ 28,612 men, smelted 5,433,547 tons of charge in its furnaces, refined 990,295 tons of bullion, and used 413,351 tons of coal, 508,033 tons of coke, 1,836,923 bbl. of fuel oil and 6,223,869 thousands of cubic feet of gas. The company mined 1,875,991 tons of ore and 749,646 tons of coal. In 1926 it produced 360,270 tons of coke.

Detailed operating expenses are given in the report, which otherwise is brief, as usual. Crushing and concentrating machinery for the production of wolframite concentrates from tungsten ore was installed early in 1926 and has been in continuous operation since April 1, 1926. An income of $4,513 is reported during the year from the sale of wolframite ore. Development drifts driven amounted to 10,991 ft., and development raises to 4,195 ft. The B. & M. No. 2 Shaft is completed to a point 36 ft. below the 900 level.

B. C. Yates continues as general manager, with R. G. Wayland as his assistant. Edward H. Clark is president, and Fred T. Elsey, vice-president. The head office of the company is at 485 California St., San Francisco.

Homestake Still Developing Ore

Over Eleven Years' Supply Shown in Latest Annual Report

The Homestake Mining Co., operating gold mines and mills at Lead, S. D. for the last half century, reports that at the end of 1926, 744,889 tons of broken ore remained in the stopes and 15,264,399 tons remained blocked out in the mine. As 1,415,775 tons was milled during the year, the reserves are seen to equal 11.3 years' supply at that rate of operation. Last year the reserve tonnage was only 80,000 tons more, so almost a year's supply was developed to make up for that mined. In this connection the following figures are of interest:

Year	Total Ore Reserves at End of Year	Tons Milled During Year	Gold Recovered Per Ton	Tons Developed During Year
1926	16,009,288	1,415,775	$4.10	1,336,762
1925	16,088,301	1,589,701	3.77	1,175,966
1924	16,502,036	1,670,300	3.67	913,619
1923	17,258,717	1,652,337	3.87	.....

The report for the last year shows a net income of $559,320 after taxes, depreciation, depletion, and other charges, equivalent to $2.22 a share earned on the outstanding 251,160 shares of capital stock. This compares with $563,952, equal to $2.24 a share, in 1925. The dividend amounted to $7 a share in each year, about two-thirds of which comes from the depletion reserve. In other words, the company is liquidating its reserve fund.

The income account for recent years is as follows:

	1926	1925	1924	1923
Total revenues	$5,923,944	$6,079,498	$6,213,334	$6,467,592
Operating expenses, taxes and other charges	4,043,734	4,185,313	4,205,931	4,192,490
Depreciation and depletion	1,320,890	1,330,233	1,323,759	1,343,443
Net income	$559,320	$563,952	$683,644	$931,659
Dividends	1,758,120	1,758,120	1,758,120	1,506,960

Copper production data published by *Revista Financiera* give the following figures in metric tons for the output of the Chile Copper Co. and the Braden Copper Co.:

	Chile	Braden
1925—Year	99,720	69,908
1926—January	8,297	7,534
February	8,300	7,534
March	8,296	7,463
April	8,295	5,639
May	8,291	6,535
June	8,297	5,222
July	8,297	5,120
August	8,295	5,717
September	8,500	6,400
October	8,501	7,272
November	8,501	9,273

The Market Report

Metal Markets Quieter; Prices Steady

New York, March 9, 1927.—Buying in the non-ferrous metal markets has been on a considerably reduced scale during the week ending today. Copper is particularly quiet.

Copper Market at Standstill

Following five successive weeks of active buying in the domestic copper market, has come a decided lull. Producers are in an easy position, but at the same time consumers for the most part are well supplied and are content to await developments. Such sales as were made brought 13.375c. in Connecticut, with Midwest business commanding an eighth and in some instances a quarter of a cent over the Eastern figure. Almost no business has been done on the first three days of the current calendar week, but sellers were unanimous in holding at 13.375c. until today, when the only substantial sale was made at 13.35c., Valley. Brass business continues good, and with a fair volume of buying on the part of wire mills producers argue that consumption will be equal to, if not in excess of, the rate of production in coming months. Official and semi-official statements from authoritative sources make it certain that many of the large producers are curtailing output, and unless unexpected increases from other sources offset these decreases, a net reduction of from 10 to 15 per cent in world's production should materialize. The foreign price of Copper Exporters, Inc., has been 13.65c. c.i.f. all week, and the business thus far in March has been good. A few f.a.s. sales have been made at 13.275c.

Lead Active and Higher

Last Thursday, March 3, the American Smelting & Refining Co. surprised the trade by advancing its contract price of New York lead from 7.55 to 7.65c., following an advance of 15 points made the day before. London was again up on that day, and it was felt that the strength of the market justified the 7.65c. quotation. Buying was active on both Thursday and Friday, and a good business has also been done since. A good deal of this has been to Middle Western consumers, who have bought liberally for March and early April shipment. Specifications on contracts, on the other hand, have been somewhat disappointing, and battery manufacturers show little interest.

Prices in the Middle West have been very mixed, depending on the seller and the time of delivery. Last Thursday, for example, lead sold all the way from 7.35c., St. Louis, to 7.625c. for June delivery, and on Monday as high as 7.70c. was done for June, though plenty of lead was available at 7.45c. for March. Most sellers declined to quote beyond April. With the slight weakness in London the last two or three days, and an easing up of domestic business, sellers have been disposed to shade prices a little, and sales today have been pretty well divided between 7.40 and 7.45c. for March and April, depending on the seller. In the East, practically all business throughout the week has been booked at the 7.65c., New York, basis. The lead market is generally firm, with no immediate move in either direction likely.

Zinc at 6.75c.

Little change has occurred in the zinc market during the week, though prices today are a little easier than a week ago. Apparently the curtailment in the mine production in Joplin did not last long, and the expectation is that smelter production figures for February will show little change in the rate of output. Accordingly, unless deliveries increase, which is not likely, stocks at the end of February will be as high as or higher than a month previous. Galvanizers are not buying ahead to any great extent, for they feel that the market position is in their favor. However, at current prices the profits of smelters are not great, and they are disinclined to make concessions to induce buying. High Grade is dull at 8½c., delivered in New York.

Tin Quiet Around 70c.

The tin market has not been active. Prices for prompt Straits early in the week were much under London parity; a deliberate effort was apparently made to sell tin to weak holders to depress the London market, or possibly to shake out tin here. Recently, however, the market here has turned stronger,

Daily Prices of Metals

Mar.	Copper	Tin		Lead		Zinc
	Electrolytic, N. Y.	99 Per Cent	Straits	N. Y.	St. L.	St. L.
3	13.175	68.25	70.25	7.65	7.35@7.50	6.80
4	13.175	68.50	70.25	7.65	7.35@7.50	6.80@6.825
5	13.15	68.75	70.25	7.65	7.45@7.525	6.80
7	13.15	67.875	69.875	7.65	7.50	6.75@6.775
8	13.15	68.00	70.00	7.65	7.40@7.50	6.75
9	13.125@13.15	68.50	70.25	7.65	7.40@7.45	6.75
Av.	13.156	68.313	70.146	7.650	7.452	6.779

Average prices for calendar week ending March 5, 1927, are: Copper, 13.138c.; 99 per cent tin, 67.938c.; Straits, 70.021c.; N. Y. lead, 7.571c.; St. L. lead, 7.406c.; zinc, 6.813c.; and silver, 56.000c.

The above quotations are our appraisal of the major markets for domestic consumption based on sales reported by producers and agencies. They are reduced to the basis of cash, New York or St. Louis, as noted. All prices are in cents per pound.

Copper, lead, and zinc quotations are based on sales for both prompt and future deliveries; tin quotations are for prompt delivery only.

In the trade, copper prices usually are quoted on a delivered basis; i.e., delivered at consumer's plant. As delivery and interest charges vary with the destination, the figures shown above are net prices at refineries on the Atlantic seaboard.

Quotations for copper are for ordinary forms of wire bars, ingot bars, and cakes. For ingots an extra 0.05c. per pound is charged and there are other extras for other shapes. Cathodes are sold at a discount of 0.125c. per lb.

Quotations for zinc are for ordinary Prime Western brands. Zinc in New York is now quoted at 0.35c. per pound above St. Louis, this being the freight rate between the two points.

Quotations for lead reflect prices obtained for common lead, and do not include grades on which a premium is asked.

London

March	Copper			Tin		Lead		Zinc	
	Standard		Electrolytic						
	Spot	3M		Spot	3M	Spot	3M	Spot	3M
3	56 7/8	57 3/8	63	316 1/4	301 1/2	28 5/8	29 1/16	31 1/8	31 5/16
4	56 3/4	57 1/4	63	319 1/2	301 3/4	28 7/8	29 1/4	31 1/8	31 3/8
7	56 1/8	56 3/4	63	317 1/2	300 1/2	28 9/16	29 1/16	30 5/8	31
8	56 1/8	56 5/8	62 1/2	313	299 1/2	28 1/8	28 3/4	30 7/8	31 1/8
9	55 3/4	56 5/16	62 1/2	315 1/4	301 1/4	28 3/16	28 3/4	31	31 1/2

The above table gives the closing quotations on the London Metal Exchange. All prices in pounds sterling per ton of 2,240 lb.

Silver, Gold, and Sterling Exchange

Mar.	Sterling Exchange "Checks"	Silver		Gold London	Mar.	Sterling Exchange "Checks"	Silver		Gold London
		New York	London				New York	London	
3	4.84 5/8	55 1/2	25 1/16	84s11½d	7	4 84 3/8	55 3/4	25 7/8	84s10½d
4	4 84 3/8	55 5/8	25 3/4	84s10½d	8	4 84 3/8	55 7/8	26 1/16	84s10¾d
5	4.84 3/4	56 1/8	26		9	4 84 3/8	55 1/4	25 9/16	84s10¾d
					Avg.		55.688		

New York quotations are as reported by Handy & Harman and are in cents per troy ounce of bar silver, 999 fine. London silver quotations are in pence per troy ounce of sterling silver, 925 fine. Sterling quotations represent the demand market in the forenoon. Cables command one-half cent premium.

though today's quotations are largely nominal. Tin of 99 per cent grade is very scarce, and the differential between that and Straits is apparently wider than justified. Some 99 per cent tin of German origin is offered at concessions.

Silver Lower and Weak

The demand for silver from India has fallen off somewhat during the last week, and this factor, combined with weakness in China exchanges, has occasioned lower silver prices. Another factor said to have a depressing effect is the reported passage on March 8 of the bill embodying those recommendations of the Indian Currency Commission which stabilize the rupee in relation to gold on a basis of 1s. 6d. It is proposed this bill will become effective April 1, 1927.

Mexican Dollars (Old Mexican pesos) March 3d, 42¼c.; 4th, 42⅜c.; 5th, 42⅝c.; 7th, 42½c.; 8th, 42⅝c.; 9th, 42c.

Foreign Exchanges Quiet

Little change has occurred in the principal foreign currencies, closing cable quotations on Tuesday, March 8, being: francs, 3.91⅜c.; lire, 4.42c.; and marks, 23.71c. Canadian dollars, 3/16 per cent discount.

Other Metals

Quotations cover large wholesale lots unless otherwise specified. London prices are according to latest mail advices.

Aluminum—Per lb., 98 or 99 per cent grade, price of leading interest, 26c.; outside market, 25.30@26c. London, 98 per cent, £105@£107 per long ton for domestic consumption.

Antimony—Per lb., duty paid, New York: Chinese brands, spot, 13½c.@12½c.; April prices about ¼@¼c. less; Cookson's "C" grade, spot, 17½c. Market dull. Needle antimony nominally 8c. for lump and 10c. for powdered. White oxide, 16½c.

Bismuth—Per lb., New York, in ton lots, $2.70@$2.75. London, 10s.

Cadmium—Per lb., New York, 60c. London, Australian metal selling freely at 1s. 10d.

Iridium—Per oz., $115@$120 for 98 @99 per cent sponge and powder.

Nickel — Per lb., ingot, 35c.; shot, 36c.; electrolytic, 39c. (99.75 per cent grade). London, £170@£175 per long ton, according to quantity.

Palladium—Per oz., $58@$62. Small lots bring up to $68. Dull. Pure metal as a constituent of crude platinum, $55@$59 per oz. London, £11@£12, nominal.

Platinum — Official price quoted by the leading interest on miscellaneous orders for refined metal, $108. Open market cash sales of large lots, in New York, $101@$103. Pure metal as a constituent of crude platinum, $100@$101. Market remains dull.

London, £22 per oz. for refined and £18½@£19½ for crude. Dull.

Quicksilver—Per 75-lb. flask, $103.50 @$104.50. Market stronger. San Francisco wires $102.33, steady. London, £17½.

The prices of Cobalt, Germanium Oxide, Lithium, Magnesium, Molybdenum, Monel Metal, Osmium, Radium, Rhodium, Ruthenium, Selenium, Tellurium, Thallium, Tungsten, and **Zirconium** are unchanged from the issue of March 5.

Metallic Ores

Manganese Ore—Per long ton unit of Mn, c.i.f. North Atlantic ports, minimum 47 per cent Mn, 36@38c. Caucasian (washed), 53@55 per cent, 38@40c. Chemical grades unchanged from quotations in the March 5 issue.

Tungsten Ore — Per unit of WO_3, N. Y.: Wolframite, $10.75@$11; Western scheelite, $11.25@$11.50. Dull; prices largely nominal.

Chrome, Iron, Molybdenum, Tantalum, Titanium, Uranium, and Vanadium Ores are unchanged from quotations in the March 5 issue.

Lead Ore Again Higher—Zinc Blende Unchanged

Joplin, Mo., March 5, 1927

Blende

High	$49.60
Premium blende, basis 60 per cent zinc	$46.00@47.00
Prime Western, basis 60 per cent zinc	45.00@46.00
Fines and slimes, 60 per cent zinc	44.00@42.00
Average settling price, all zinc	43.62

Galena

High	$100.80
Basis 80 per cent lead	100.00
Average settling price, all lead	98.40

Shipments for the week: Blende, 19,018; lead, 2,597 tons. Value, all ores, $1,086,670.

The Commerce Mining and Royalty Co. marketed 4,683 tons of the zinc and 791 tons of the lead from Kansas. This company holds the greater portion of the zinc concentrate stock in Oklahoma, and seldom sells except when the market reaches a point which the company considers advantageous.

There was no change in offerings for zinc ore, and buyers were able to purchase only 13,260 tons today. Lead was advanced to $100 basis, and it is reported that a large portion of the tonnage bought last week and loaded this week was settled for on that basis.

Platteville, Wis., March 5, 1927

Zinc Blende	Per Ton
Blende, basis 60 per cent zinc	$47.75
Lead Ore	
Lead, basis 80 per cent lead	$97.50

Shipments for the week: Blende, 1,375 tons; lead, none. Shipments for the year: Blende, 12,408; lead, 340 tons. Shipments for the week to separating plants, 2,159 tons blende.

Non-Metallic Minerals

Amblygonite, Asbestos, Barytes, Bauxite, Borax, Celestite, Chalk, China Clay, Diatomite, Emery, Feldspar, Fluorspar, Fullers Earth, Garnet, Gilsonite, Graphite, Greensand. Gypsum, Iron Oxide, Lepidolite, Limestone, Magnesite, Mica, Monazite, Ocher, Phosphate, Potash, Pumice, Pyrites, Quartz Rock Crystal, Silica, Spodumene, Sulphur, Talc, Tripoli, and **Zircon** are unchanged from prices in the March 5 issue.

Mineral Products

Arsenious Oxide (White Arsenic)—3¾c per lb. Quiet. A few hundred tons of barreled Mexican arsenic is available for immediate shipment at a concession.

Calcium Molybdate, Copper Sulphate, Sodium Nitrate, Sodium Sulphate (Salt Cake), and **Zinc Oxide** are unchanged from prices in the March 5 issue.

Ferro-Alloys

Ferromanganese—Domestic and foreign, 78@82 per cent, $100 per long ton, furnace or duty paid, for delivery during first half of 1927. Spiegeleisen, 19@21 per cent, $36@$37, f.o.b. furnace; 16@19 per cent, $34@$35.

Ferrotungsten—$1@$1.05 per lb. of W contained, f.o.b. works. Market spotty.

Ferrocerium, Ferrochrome, Ferrophosphorus, Ferrosilicon, Ferrotitanium, Ferro-uranium and **Ferrovanadium** are unchanged from prices in the March 5 issue.

Metal Products

Rolled Copper—Sheets, 22c.; wire, 15¼c. f.o.b. mill.

Lead Sheets—Full rolled, 11c. per lb.; clipped, 11½c.

Nickel Silver—29c. per lb. for 18 per cent nickel Grade A sheets.

Yellow (Muntz) Metal—Dimension sheets, 19⅜c. per lb.; rods, 16⅜c.

Zinc Sheets—11c. per lb., f.o.b. mill.

Refractories

Chrome Brick, Fireclay Brick, Magnesite Brick, Silica Brick and **Zirkite** are unchanged from quotations in the March 5 issue.

Steel Prices Harden—Pig Iron Higher—Coke Quiet

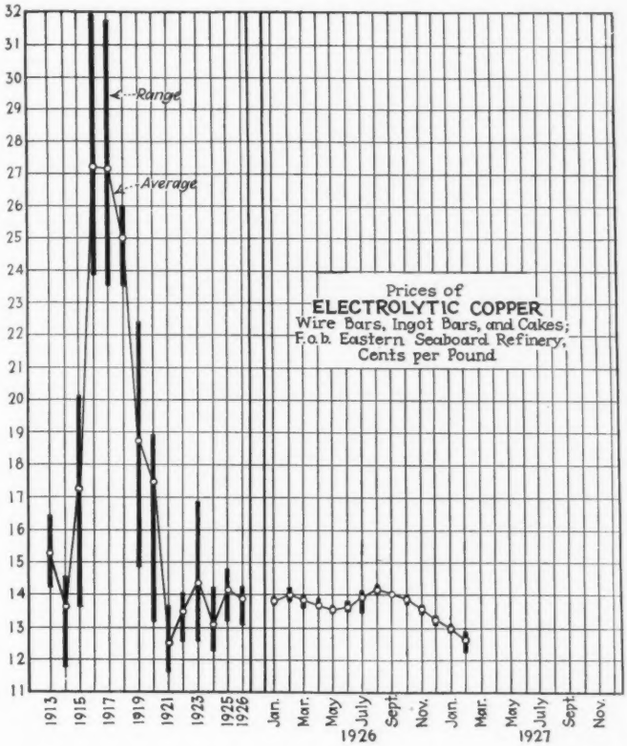
Pittsburgh, March 8, 1927

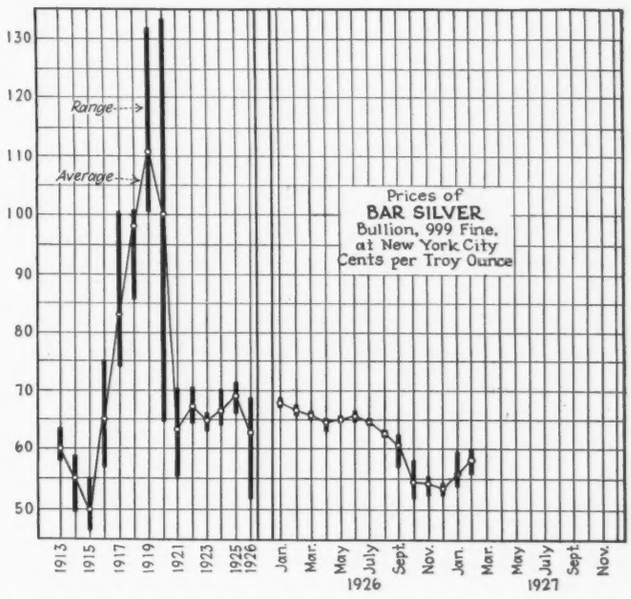
The steel industry entered March with an operating rate above 85 per cent and may show 90 per cent for the month, which for three successive years has been the high month of the year in production, last March showing 92.58 per cent.

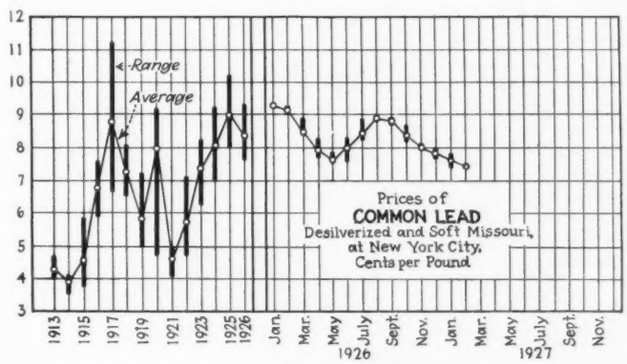
Pig Iron—Cleveland producers have advanced prices after a period of heavy selling at close prices. Valley prices are unchanged, but the undertone is stronger, furnace stocks being reduced. Bessemer, $19; basic, $18; foundry, $18.50, f.o.b. Valley furnaces.

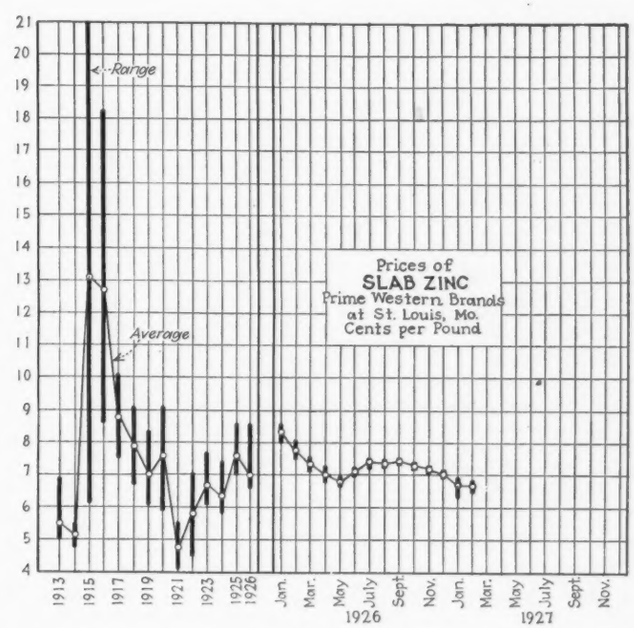
Connellsville Coke—The turnover in spot coke remains rather light, with furnace at $3.35@$3.50 and foundry at $4.25@$4.75. There is no disposition as yet to negotiate second-quarter contracts. The majority opinion is that there will not be much striking in the region, which is strictly non-union, in connection with the union bituminous coal strike.

Metal Price Curves

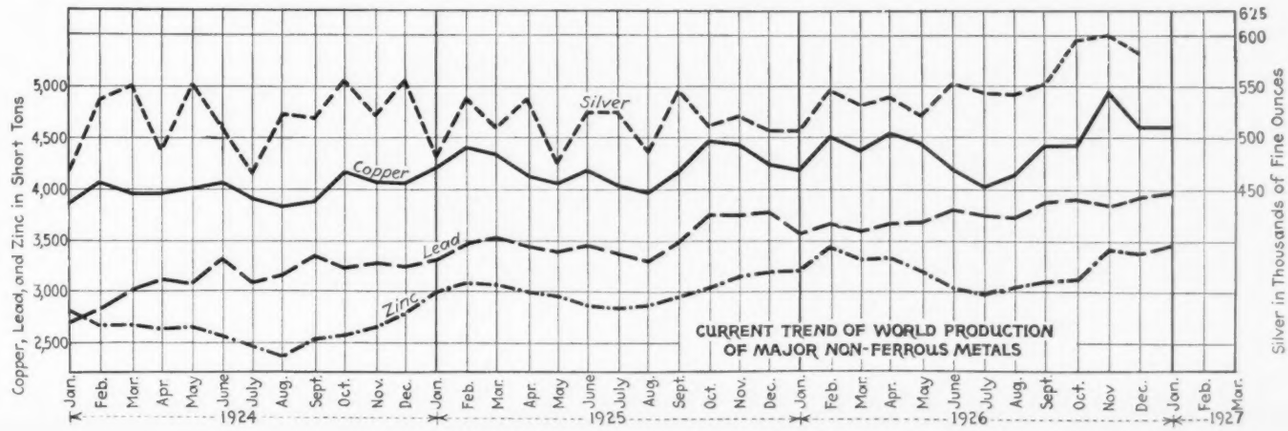








THE curves below are not to be considered as permanent records of production. They show merely the current trend in terms of daily output, according to latest estimates of the American Bureau of Metal Statistics. The figures represent countries that produced in 1924 and 1925 about 97 per cent of the world's output of copper; 78 per cent of the lead; 87.5 per cent of the zinc; and 81 per cent of the silver. Figures now being published by the Bureau include a larger proportion of the world output than those stated. However, until these have been in effect for a sufficient period of time to give a "history" for purpose of comparison, it is thought desirable to make the necessary adjustment in the data and extend the curve on the basis that has been in vogue for two years.



Review of Current Statistics

By A. B. Parsons
Assistant Editor

BY THE narrowest possible margin, the *Engineering and Mining Journal's* Weighted Index of Non-Ferrous Metal Prices has remained on the high side of the composite for 1922, 1923, and 1924. The figure for February is 100.01. Only substantial improvement in the monthly averages for silver and tin saved the day, as both copper and lead sagged badly. Copper touched 12.50c. delivered in Connecticut, the lowest point reached since the middle of 1924, and lead remained during the entire month at 7.40c. New York, except for some metal that brought moderate premiums in the "outside" market. Again it is necessary to revert to 1924 to find a price equally low.

However, it seems likely that the worst is over. Copper in two weeks has recovered to about 13.375c.; and in the first four days of March, the American Smelting & Refining Co. made two advances in its New York price for lead, the latter bringing it to 7.65c. In spite of numerous transactions at higher prices in the domestic market and of steady appreciation in London, the Smelting company was slow in marking up its price. Seemingly it delayed action until it felt reasonably sure that no move in the opposite direction might be necessary in the near future. The tendency of the lead market, thanks to the efforts of leading sellers to prevent erratic fluctuations, has been to move in long swings.

A view of the lead market held by many in that a climb is ahead. They point to the curtailment in production that is reported to have been put into effect recently, to sundry signs of continued industrial activity (about which there is more unanimity of opinion than existed a month or two ago), and to some improvement in the European situation. The United States has been absorbing virtually all of Mexico's ore lead for many months; but if Europe will bid for some of this metal the effect on the domestic market will be favorable. All of which is not to say that the skeptical ones, who look for a brief advance followed by a reaction, may not be right.

Copper buying during February was in almost record-breaking volume in both the domestic and foreign markets, though, as might be expected, most of the business was near the lower end of the wide price range. Even with good domestic consumption, buying is likely to be comparatively light for a time, and further advance in the price, or even the holding of the present level, is problematical. Reports (few of them official but probably not without sound basis of fact) indicate that curtailment in production may be expected. Possibly the rapid skidding of the price to 12½c. was a good thing if it shocked some of the producers into a realization of what might happen if output were allowed to swell without restraint.

Zinc fluctuated within narrower limits during February than during the preceding month, with the average just a shade higher. Aluminum declined moderately under continued pressure of competition in the "outside" market. The leading interest maintained its price at 26c. per pound, but independents cut under that figure. Tin, in consequence of smaller shipments from the Straits, as well as bullish speculative trading both here and abroad, advanced sharply, averaging more than 69c. for the month. Silver touched 60c. during February, and averaged just under 58c., though the price at the close had reacted to 56⅛c. No good reason exists for anticipating a serious decline.

E.&M.J. Weighted Index of Non-Ferrous Metal Prices

100 Is Composite for 1922-3-4

1920	130.92
1921	80.80
1922	93.94
1923	103.43
1924	102.63
1925	111.74
1926	107.74

	1925	1926	1927
August	113.61	110.22	
September	114.66	109.27	
October	115.64	106.20	
November	116.69	104.21	
December	114.15	102.31	
January	116.38	112.66	100.46
February	113.50	111.91	100.01

The preponderant elements in the weighted index are copper, lead, and silver. With the prospects for the first two favorable, it is altogether likely that March will see an upturn in the index that for six months has been declining steadily. The habit of the curve, as shown on the page facing this, has been to follow trends, once established, for periods of several consecutive months. The optimist has a good argument on this basis at least.

Slightly lower prices for barytes, following an advance in January, account for a fractional decline in the Index of Non-Metallic Mineral Prices. The other minerals remained unchanged.

Appreciation in all of the indexes of the stock-market valuation of shares was recorded during the month. This movement was in accord with the trend of the general list of stocks in New York. In the mining-smelting-manufacturing group, each of the seven made gains. American Smelting & Refining more than recovered the ground lost in January and recently has passed $153 on the strength of the publication of its highly satisfactory annual report. International Nickel was the next largest factor in the gain of this group, followed by National Lead. Wall Street is looking for a stock "distribution" in National Lead, which doubtless accounts for the strength in the stock.

Three "coppers" declined: Inspiration, Calumet & Hecla, and New Cornelia. The most serious weakness was in Inspiration, which has gone down in three consecutive months from about $26½ to $22. The other companies in the group all advanced. Kennecott, United Verde Extension, Granby, Calumet & Arizona, and Chile were the leaders.

Hollinger, northern Ontario's candidate for the place as the world's "biggest" gold mine, was the feature of the third group. The shares passed the $22 mark for a new high. Lake Shore, another gold property in Ontario; Premier, A.S.&R. subsidiary in British Columbia; Utah-Apex, that is recovering some lost ground; and Cerro de Pasco, contributed to the gain. The only shares to decline materially were Hecla and Federal M.&S. A court decision adverse to the payment of common dividends affected the latter. Hecla, producing lead and silver, usually fluctuates in close accord with the metal markets. It has been going down steadily since last summer.

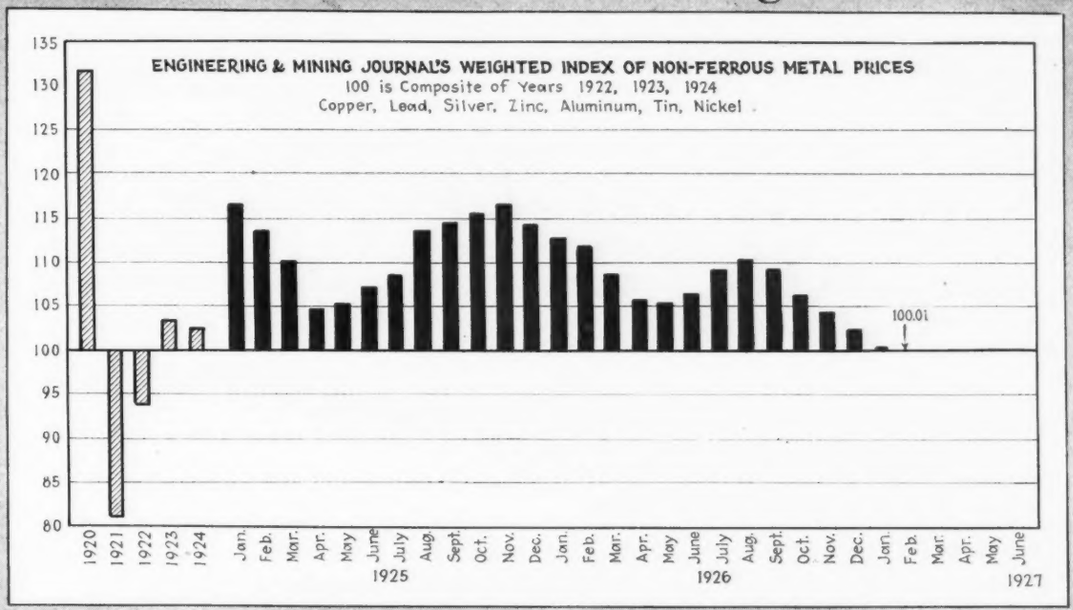
Stocks of metal have been increasing, as indicated by the dot-and-dash curves on the charts at the bottom of the page facing this. All data are from the American Bureau of Metal Statistics. Both copper and lead stocks have reached new high levels for recent years; and zinc, at the end of January, was at the high level of last May. The increase in copper stocks during the last five months is attributable to lower domestic shipments as well as to increased production. Judging from the sales record of February, the curve for domestic shipments should show an early upward movement. Refined production in January established a new high record in the history of the industry. On the other hand, the rate of world's mine production has declined somewhat from the high of November as shown on page 469.

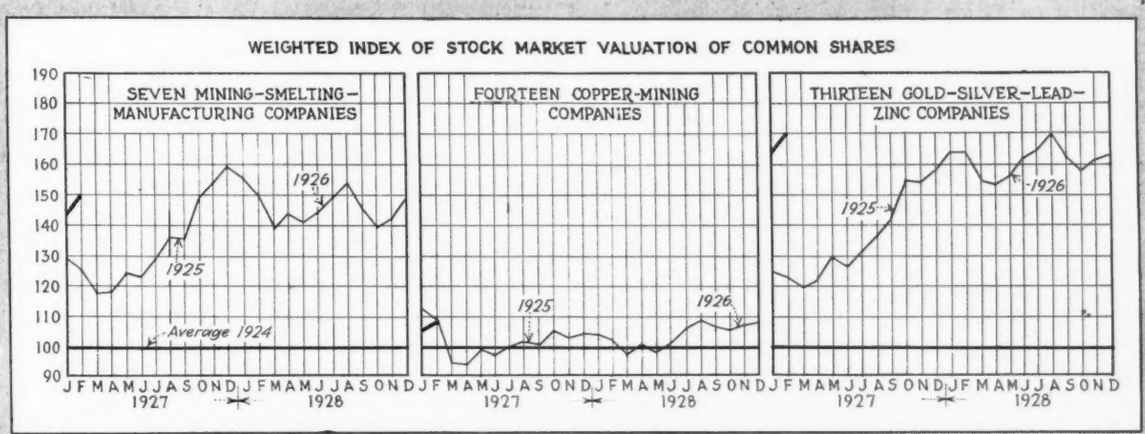
Changes in the trend of zinc and lead statistics are not decisive except for the increase in stocks and a slight decline in domestic deliveries of zinc during December and January. The rates of world production have changed but little, although that of lead reached a new high level in January.

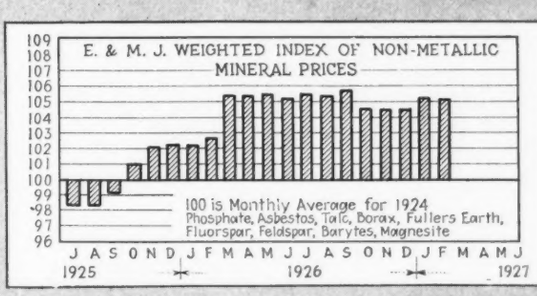
Statistics of silver production in Mexico are now available for the last two months of 1926. They show a record-breaking output for the southern republic, and place the world's production rate for the last three months of the year at extremely high levels. This is a factor in the weakness of the price for silver that cannot be entirely ignored, although it is doubtless overshadowed by the position taken by China and India in the world's silver market.

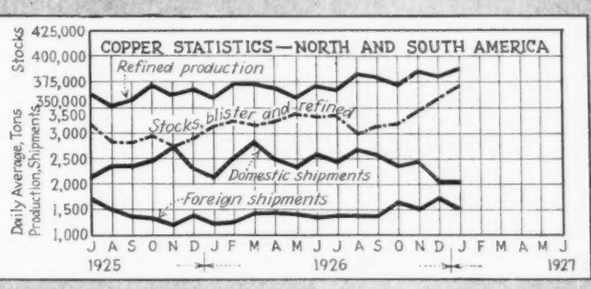
In general it may be said that the statistics—prices, shipments, stocks, production, and other factors—do not indicate exuberant earnings for metal producers since the first of the year; but at the same time they suggest the probability of early and considerable improvement. The strength in the share market reveals an optimistic attitude in financial circles and tends to confirm the forecast for better times just ahead.

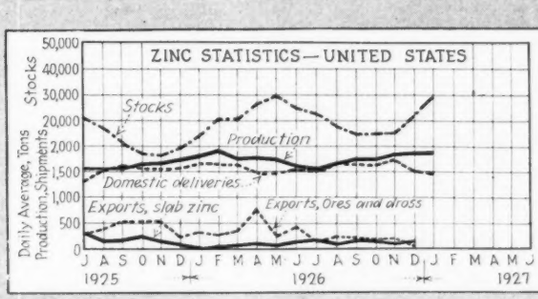
E.&M.J. Statistics of the Mining Industries

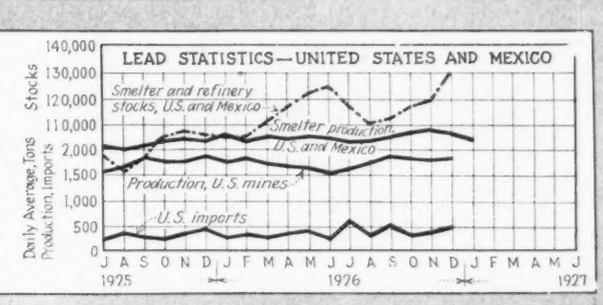

ENGINEERING & MINING JOURNAL'S WEIGHTED INDEX OF NON-FERROUS METAL PRICES
100 is Composite of Years 1922, 1923, 1924
Copper, Lead, Silver, Zinc, Aluminum, Tin, Nickel
100.01
1920 1921 1922 1923 1924 Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June
1925 1926 1927


WEIGHTED INDEX OF STOCK MARKET VALUATION OF COMMON SHARES
SEVEN MINING-SMELTING-MANUFACTURING COMPANIES
1926
1925
Average 1924
FOURTEEN COPPER-MINING COMPANIES
1925
1926
THIRTEEN GOLD-SILVER-LEAD-ZINC COMPANIES
1925
1926
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928


E. & M. J. WEIGHTED INDEX OF NON-METALLIC MINERAL PRICES
100 is Monthly Average for 1924
Phosphate, Asbestos, Talc, Borax, Fullers Earth, Fluorspar, Feldspar, Barytes, Magnesite
J A S O N D J F M A M J J A S O N D J F M A M J
1925 1926 1927


COPPER STATISTICS—NORTH AND SOUTH AMERICA
Stocks
Daily Average, Tons Production, Shipments
Refined production
Stocks, blister and refined
Domestic shipments
Foreign shipments
J A S O N D J F M A M J J A S O N D J F M A M J
1925 1926 1927


ZINC STATISTICS—UNITED STATES
Stocks
Daily Average, Tons Production, Shipments
Stocks
Production
Domestic deliveries
Exports, slab zinc
Exports, Ores and dross
J A S O N D J F M A M J J A S O N D J F M A M J
1925 1926 1927


LEAD STATISTICS—UNITED STATES AND MEXICO
Stocks
Daily Average, Tons Production, Imports
Smelter and refinery stocks, U.S. and Mexico
Smelter production U.S. and Mexico
Production, U.S. mines
U.S. imports
J A S O N D J F M A M J J A S O N D J F M A M J
1925 1926 1927

Mining Stocks—Week Ended March 5, 1927

Stock	Exch.	High	Low	Last		Last Div.
COPPER						
Anaconda	New York	48⅛	47	47½	Ja. 15, Fe. 21	Q 0.75
Arcadian Consol.	Boston	....	....	*50	....	....
Ariz. Com'l.	Boston	9	7⅞	8	Ja. 7, Ja. 28	0.50
Calaveras	N. Y. Curb	1⅛	1⅛	1⅛	....	....
Calumet & Arizona	New York	67⅛	66½	67½	Ma. 5, Ma. 21	Q 1.50
Calumet & Hecla	Boston	15½	15	15	Fe.28, Ma.15	Q 0.50
Cerro de Pasco	New York	61⅛	61⅛	61½	Ja.13,Fe.1, Q	1.00
Chile Copper	New York	36⅛	36⅛	36⅛	Ma.4,Apr.1, Q	0.62½
Con. Coppermines	N. Y. Curb	2⅛	2⅛	2⅛	....	....
Copper Range	Boston	13⅞	13½	13⅝	May, 1926	1.00
Crystal Copper	Boston Curb	*29	*25	*28	....	....
East Butte	Boston	2⅛	2⅛	2⅛	Dec., 1919	0.50
Granby Consol.	New York	37½	36	36	May, 1919	1.25
Greene-Cananea	New York	39¼	33	37⅛	Nov., 1920	0.50
Hancock	Boston	....	....	*40	....	....
Howe Sound	New York	39⅛	38⅛	39⅛	De 31, Ja.15	Q 1.00
Inspiration Consl.	New York	22	21⅛	21⅛	Ma.17, Ap.4	Q 0.25
Iron Cap	Boston Curb	1⅛	1⅛	1⅛	....	....
Isle Royale	Boston	10	10	10	Fe.4, Fe.19	Q 0.50
Kennecott	New York	64½	62⅝	62⅞	Mar. 4 Apr. 1	Q 1.25
Magma Copper	New York	36	35⅛	36	Dec. 1, Ja.15	Q 0.75
Mason Valley	N. Y. Curb	1⅝	1⅝	1⅝	....	....
Miami Copper	New York	16⅛	16⅛	16¼	Fe.1, Fe. 15	Q 0.37½
Mohawk	Boston	40⅜	39½	40	Ja.29, Ma.1	Q 1.00
Mother Lode Coa.	New York	4¼	4¼	4¼	De.10, De.31	SA 0.37½
Nevada Consol.	New York	14⅛	14⅛	14⅛	De.15, De.31	Q 0.37½
New Cornelia	Boston	23	22½	22⅝	Fe.4, Fe.21	Q 0.50
Noranda	N. Y. Curb	22⅛	20⅛	20½	....	....
North Butte	Boston	2⅜	2⅛	2⅛	Oct., 1918	0.25
Ohio Copper	N. Y. Curb	*48	*40	*48	Se. 1, Se. 15	0.03
Old Dominion	Boston	13⅞	13⅛	13⅛	Dec., 1918	1.00
Phelps Dodge	Open Mar.	†128	†125	....	De.24, Ja.3	Q 1.50
Quincy	Boston	15⅜	14⅜	15	Mar., 1926	1.00
Ray Consolidated	New York	15⅛	15⅛	15⅛	Ap.20, Ap.30	0.25
St. Mary's Min. Ld.	Boston	24⅛	24	24	Fe.10 Ma.10	2.00
Seneca Copper	New York	3	3	3	....	....
Shattuck-Denn	Boston Curb	5⅛	5⅛	5⅛	....	....
Tenn. C. & C.	New York	12⅜	11⅞	11⅞	Fe.28, Ma.15, Q	0.25
United Verde Ex.	N. Y. Curb	27½	26	27	Ja. 6, Fe. 1	0.75
Utah Copper	New York	112½	112⅛	112⅛	De.15, De.31	Q 1.50
Utah Metal & T.	Boston	1⅞	1⅛	1⅛	Dec., 1917	0.30
Walker Mining	Salt Lake	*81	*77	*77	....	....
NICKEL-COPPER						
Internat. Nickel	New York	43	40⅜	41	De.16, De.31, Q	0.50
Internat. Nickel, pfd.	New York	103⅜	103⅛	103⅝	Ja. 13, Fe.1, Q	1.50
LEAD						
Gladstone Mtn.	Spokane	*29⅛	*28⅛	*28⅜	Fe. 1927	0.005
National Lead	New York	186½	175	180	Ma.11, Ma.31	Q 2.00
National Lead pfd.	New York	117⅜	117⅜	117⅜	No.19, De.15	Q 1.75
St. Joseph Lead	New York	43⅞	41⅛	43	Jn.10, Jn.20, Q	X 0.75
ZINC						
Am. Z. L. & S.	New York	9⅜	9⅛	9⅜	May, 1917	1.00
Am. Z. L. & S, pfd.	New York	49⅜	47	48¼	Nov., 1920	1.50
Butte C. & Z.	New York	4	4	4	De.9, De.24	0.50
Butte & Superior	New York	11⅝	11	11	Ma.15, Ma.31	Q 0.50
Callahan Zn-Ld.	New York	2⅛	2	2	Dec., 1920	0.50
Eagle-Picher	Cincinnati	27¼	26⅞	27⅛	Fe.15, Ma.1	Q 0.40
Eagle-Picher, pfd.	Cincinnati	....	....	100	De.31, Ja.15	Q 1.50
New Jersey Zn.	N. Y. Curb	183⅜	183	183⅜	Ja.20, Fe.10	Q 2.00
United Zinc	N. Y. Curb	....	....	55	....	....
Yellow Pine	Los Angeles	*35	*25	*27	Dec. 1925	Q 0.04
GOLD						
Alaska Juneau	New York	2⅛	1⅝	1⅝	....	....
Argonaut	Toronto	*48	*37	*41½	....	....
Barry-Hollinger	Toronto	*50	*41	*45	....	....
Carson Hill	Boston	*11	*11	*11	....	....
Consol. W. Dome L.	Toronto	*15½	....	....	....	....
Cresson Consol. G.	N. Y. Curb	2⅛	2 1/16	2⅛	De.31, Ja.10	Q 0.10
Dome Mines	New York	8⅜	8⅛	8⅜	De.31, Ja.30,	Q 0.50
Golden Center	N. Y. Curb	*7	*6	*6	....	....
Golden Cycle	N. Y. Curb	1⅜	1⅛	1⅜	No.30, De.10	Q 0.04
Hollinger Consol.	Toronto	22.10	21.25	21.25	Ma.9, Ma.25	0.10
Homestake Mining	New York	61	61	61	Ma.19, Ma.25	M 0.50
Kirkland Lake	Toronto	*91	*87	*87	....	....
Lake Shore	Toronto	19.00	18.25	18.38	Ma.1, Ma.15	0.10
McIntyre-Porcupine	New York	27⅛	27	27	Fe.1, Ma.1	Q 0.25
Portland	Colo Springs	†*55	†*53	....	Ja.6, Ja.15, '27	0.02
Rand Mines	New York	....	....	9⅛	Au.23-30	Am.Sh. 1.52
Teck-Hughes	Toronto	6.76	6.30	6.32	Ja.31, Fe. 1	0.05
Tom Reed	Los Angeles	*50	*50	*50	Dec., 1926	0.02
Tough-Oakes	Toronto	*57	*53	*54½	....	....
United Eastern	N. Y. Curb	*45	*45	*45	July, 1924	0.05
Vipond Cons.	Toronto	1.50	1.25	1.43	Apr.1 Apr.15	0.03
Wright-Hargreaves	Toronto	11.00	10.40	10.75	Ja.15, Fe.1	Q X 0.15
GOLD AND SILVER						
Carnegie Metals	Pittsburgh	13	13	13	....	....
Con. Cortes	N. Y. Curb	*23	*18	*20	....	....
Con. Virginia	San Francisco	*3⅛	*3⅛	*3⅛	....	....
Dolores Esperanza	N. Y. Curb	....	....	40	July, 1923	0.05
Premier Gold	N. Y. Curb	....	....	2⅛	Ma.15, Ap.4	Q 0.08
Tonopah Belmont	N. Y. Curb	1⅛	1⅛	1⅛	Se.15, Oc.1	0.05
Tonopah Extension	N. Y. Curb	27	26	26	Apr. 1925	0.05
Tonopah Mining	N. Y. Curb	3	2⅞	2⅞	Ma.31, Apr.21	0.07½
West End Consol.	N. Y. Curb	*14	*11	*14	Mar., 1923	0.05
Yukon Gold	N. Y. Curb	....	....	*45	June, 1918	0.02
SILVER						
Beaver Consol.	Toronto	*68	*66	*67½	May. 1920	0.03
Canadian Lorrain	Toronto	*50	46½	*48	....	....
Castle-Trethewey	Toronto	1.07	1.05	1.05	....	....
Coniagas	Toronto	4.00	4.00	4.00	May. 1924	0.12½
Keeley	Toronto	1.46	1.42	1.42	Fe.28, Ma.	X 0.12½
Lorrain Trout Lake	Toronto	....	....	*30	July, 1925	0.05
McKinley-Dar.-Sav.	Toronto	*16	*14	*14	Oct., 1920	0.03

Stock	Exch.	High	Low	Last		Last Div.
SILVER—(Continued)						
Mining Corp. Can.	Toronto	3.30	3.12	3.12	De.30, Ja.15	0.12½
Nipissing	N. Y. Curb	9⅛	8⅜	8⅜	De.31, Ja.20	Q 0.15
SILVER-LEAD						
Ahumada	New York	5⅛	4⅝	5⅛	De.18, Ja.5, Q	X 0.15
Bingham Mines	Boston	44⅜	43⅛	43⅛	De.30, Ja.5	Q 1.00
Cardiff M. & M.	Salt Lake	*39	*36	*36	Feb. 5, 1927	0.10
Chief Consol.	Salt Lake	2.85	2.75	2.75	Oc.10, No.1	Q 0.10
Consti'n Mng. & Mill'g	Spokane	*31	*29	*30½	....	....
Erupcion	Boston Curb	*80	*65	*75	De.18, Ja.3	Q 0.10
Eureka Lily	Salt Lake	1.40	1.10	1.25	....	....
Federal M. & S.	New York	102	90	92	....	....
Federal M. & S., pfd.	New York	84⅞	77	82⅜	Fe.24, Ma.15	Q 1.75
Hawthorne Mines	N. Y. Curb	*5	*4	*5	....	....
Hecla Mining	N. Y. Curb	14	13½	14	Fe.15, Ma.15	Q 0.25
Highland-Surprise	Spokane	*13⅜	*11⅛	*12⅜	....	....
Iron King Mining	Salt Lake	*30	*29	*29	....	....
Keystone Mining	Salt Lake	*38	*34	*34	Au.12, Au.26	0.07½
Lucky Jim	Spokane	*21⅜	*15½	*21¼	....	....
Lucky Tiger-Com.	Kansas City	†7.25	†7.00	....	Ma.20, 1927	M 0.05
Mammoth Mining	Salt Lake	2.50	2.50	2.50	De.17, De.23,	Q 0.25
Marsh Mines	Spokane	2.87½	2.37½	2.87½	....	....
North Lily	Salt Lake	3.70	3.42½	3.45	....	....
Park Utah	New York	8	7⅜	8	Ma.15, Ap.1	Q 0.20
Plutus Mining	Salt Lake	2.00	2.00	2.00	Ja.10, Ja.15	Q 0.10
San Rafael	San Francisco	*30	*30	*30	....	....
Silver King Coal	Salt Lake	8.10	7.90	8.00	De. 16, Ja.3	0.25
Silversmith	Spokane	*32	*30	*32	Oc.1, Oc.10	Q 0.02
Strattons Mines	Spokane	*46	*42	*46	....	....
Sunshine M. Co.	Spokane	*48	*46	*48	....	....
Tamarack-Custer	Spokane	*34	*32	*33½	Sept., 1924	0.25
Tintic Standard	Salt Lake	11.37½	11.12½	11.25	Ma.16, Ma.28	0.40
Utah-Apex	Boston	7⅞	6½	6⅞	Oc.3, Oc.15	Q 0.25
IRON						
Bethlehem Steel	New York	51½	48½	50	July, 1924	1.25
Cleveland-Cliffs Iron	Cleveland	74½	74	74	Ja.15, Ja.25	Q 1.00
Colorado Fuel & Iron	New York	63¼	58½	59⅜	May, 1921	0.75
Gt. North'n Iron Ore	New York	23½	21⅛	22⅜	Dec.6, Dec.28	0.75
Inland Steel	New York	43	42	42½	Fe.15, Ma.1	Q 0.62½
Replogle Steel	New York	12⅛	11⅛	12⅜	....	....
Republic I. & S.	New York	73	68½	72	Fe.15, Ma.1	Q 1.0
Republic I. & S. pfd.	New York	102⅜	102	102⅛	Ma.15, Ap.1	Q 1.75
Sloss-Sheffield S. & I.	New York	132	128½	128½	Ma.10, Ma.21	Q 1.50
Sloss-Shef. S.&I. pfd.	New York	108	108	108	Ma 21, Ap.1	Q 1.75
U. S. Steel	New York	116⅞	114⅛	114½	Fe.28, Ma.30	Q 1.75
U. S. Steel pfd.	New York	129⅛	129	129½	Ja 29, Fe.26,	Q 1 75
Virginia I. C. & C.	New York	....	....	44	Jan., 1924	1.500
Virginia I.C.&C.pfd	New York	....	....	60½	De.15, Ja.2,	2.50
DIAMONDS, PLATINUM, ALUMINUM, VANADIUM, TIN						
De Beers Consol.	New York	....	....	32½	Ja.26, Ja 29	1.45
So. Am. Gold & P.	N. Y. Curb	3⅜	3⅛	3⅜	....	....
Alum.Co.of Amer.	N.Y.Curb	72¼	72	72	....	....
Alum. Co. of Amer pf.	N.Y.Curb	102½	102⅛	102½	De.15, Ja.15	Q 0.50
Vanadium Corp.	New York	44½	42½	42½	Fe.1, Fe.15,	Q 0.75
Patino M. & E.	N. Y. Curb	....	....	25	Ma.10, Ma.15	4 sh.
ASBESTOS						
Asbestos Corp.	Montreal	22½	21	22	Jan., 1926	1.50
Asbestos Corp., pfd.	Montreal	84½	83	83½	De.31, Ja.15,	Q 1.75
SULPHUR						
Freeport Texas	New York	46	42⅜	43⅜	Ja.15, Fe.1	Q 0.50
Texas Gulf, new	New York	56⅜	53	54⅜	Ma.1, Ma.15,	Q 1 00
MINING, SMELTING, REFINING AND GENERAL						
Amer. Metal	New York	42½	41⅜	41⅜	Fe.18, Ma. 1,	Q 0 75
Amer. Metal pfd.	New York	109	108⅜	109	Fe.19, Ma.1	Q 1 75
Amer. Sm. & Ref.	New York	150½	149	150½	Ja.14, Fe.1,	Q 2 00
Amer. Sm.&Ref.pfd.	New York	121	120½	121	Fe.4, Ma.1,	Q 1.75
Consol. M. & S.	Montreal	251¼	244	251¼	De.31, Ja.15	X 6 25
Federated Metals	N. Y. Curb	13⅜	13⅛	13⅛	....	....
Newmont Mining	N. Y. Curb	72¼	68⅞	71⅛	De.31, Ja.17,	0.60
U. S. Sm. R. & M.	New York	36⅞	35	36½	Ja.6, Ja.15,	Q 0.87½
U. S. Sm. R.&M.pfd.	New York	49	49	49	Ja.6, Ja.15,	Q 0.87½

* Cents per share. † Bid or asked. Q, Quarterly. SA, Semi-annually. M, Monthly. F, four weeks. I, Initial. X, Includes extra. The first date given is that of the closing of the books; the second that of the payment of the dividend.

Boston quotations courtesy Boston Stock Exchange; Toronto quotations those of the Standard Stock Exchange of Toronto, by courtesy of Arthur E. Moysey & Co.; Spokane, Pohlman Investment Co.; Salt Lake, J. A. Hogle & Co.; Colorado Springs, Colo., Henry Sachs.

LONDON QUOTATIONS—WEEK ENDED FEB. 22, 1927

Name	High	Low	Last	Last Div. Date	Amount
Aramayo Mines (25 frs.)	79/9	76/10½	77/6	Feb. 1927	5 (†)
British Platinum (£1)	3/3¶	2/9	3/—	Feb. 1925	2½ p.c.
Burma Corpn. (10 rupees)	14/1½	13/10½	14/1½	Feb. 1927	6 annas*
Bwana M'Kubwa (5s)	6/4½	5/4½	6/1½		
Camp Bird (2s)	5/—	3/1½	5/—		
El Oro (£1)	4/6	4/4½	4/6	Nov. 1924	2½ p.c.*
Esperanza (10s)	—/2	—/2	—/2		
Frontino & Bolivia (£1)	12/6	11/10½	12/6	Jan. 1927	5 p.c.
Mexican Corpn. (£1)	10/1½	9/—	10/—		
Mexico Mines of El Oro (£1)	21/—	15/—	18/9	Dec. 1926	3½ p.c.*
N'Changa Copper Mining	17/6	16/3	16/3		
Oroville Dredging (£1)	4/9	4/8	4/9	Dec. 1923	3½ p.c.
Ouro Preto (£1)	2/1½	2/—	2/—	May 1925	2½ p.c.
Rhodesian Congo Border (£1)	79/4½	72/6	72/6		
St. John del Rey (£1)	12/9	12/1½	12/6	June 1925	6½ p.c.
San Francisco Mines (10s)	31/—	29/9	31/—	Jan. 1927	25s.
Santa Gertrudis (£1)	17/—	15/10½	16/6	Jan. 1927	3½ p.c.
Selukwe (2s. 6d.)	10/4½	9/6	9/9	April 1917	6½ p.c.
S. Amer. Copper (2s.)	3/3	3/—	3/3	Nov. 1917	75 p.c.
Tanganyika (£1)	55/6	46/6	48/1½	Aug. 1926	7½ p.c.
Tomboy (£1)	3/6	3/3	3/3	July 1926	10 p.c.
Union Miniere du Haut-Katanga (Brussels)	8.850	8.750	8.850	July 1926	175 (‡)

* Free of British income tax. † Swiss frs. ‡ Belgian frs. and free of taxatio